

LOWER SECONDARY CURRICULUM

Competency Based Physics

Scenario items

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LOWER SECONDARY PHYSICS ITEM

S3 and S4 students of a certain school were to have a motion (debate) about time durations of a day, night and seasons of a year which they normally experience in their lives. This motion was to be presented on visitation day to parents most of whom are peasants. In their debate, one presenter argued that ocean tides are the causes of these durations. Another learner supplemented that ocean tides and drought are caused by artificial satellites placed in space by powerful countries like Russia. A parent who had attended also said that seasons are brought about by the motion of the planets about the sun and this distorts climatic conditions. The audience was confused by the arguments. A learner from the audience raised an inquiry if there can be a means of getting some information about these weather changes and planets. The chairperson tasked each participant to make more research so that they could have clear information for the next presentation.

Task:

As a learner of physics, help the audience to:

- (a) Understand about time duration of the day, night and year.
- (b) Explain the occurrence of seasons and ocean tides.
- (c) Know what artificial satellites are and their roles in everyday life.

LOWER SECONDARY PHYSICS ITEM

A patient went for tooth extraction in a clinic with his eight-year-old son. The dentist was so busy and so asked his nurse to look for an optical instrument of radius of curvature 20cm with the confidence that this would give him the best magnification. The average length of a mature human tooth is 2cm. To achieve the best results, the nurse was advised to have a tooth 40cm from the instrument. As soon as the man arrived home late in the evening, the eight-year-old son started narrating to the neighbors in the next room who had closed their room to sleep. The neighbor felt sorry for the man.

Note that the available optical instruments were a concave mirror and convex lens of the same focal length.

Task:

As a learner of Physics:

- (a) Advise the nurse on the optical instrument that would best extract the tooth.
- (b) Help to explain why the neighbor was able to hear the conversation from the eight-year-old boy in the other room.

LOWER SECONDARY PHYSICS ITEM

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 learner 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.

LOWER SECONDARY PHYSICS ITEM

Your family hires three vehicles for a convoy to attend a wedding ceremony of one of your relatives. The hiring company charges a fee according to the distance moved. On a hot day, the team sets off from home with inflated balloons at 7:00am and attains a maximum velocity of 70Km/hr in 60 minutes. On reaching the highway road, it maintains this velocity for 90 minutes, finally it reaches the reception at 10:00am. It was observed that some balloons burst and only a few were left. Later in the evening it rained heavily and cars failed to reach back home due to slippery roads.

Task:

As a physics student;

- (a) Help your family members compute the distance from home to church.
- (b) Explain to your relatives the reason(s) why most of the inflated balloons burst.
- (c) Provide guidance to the car owners to avoid the problem faced during the return journey.

LOWER SECONDARY PHYSICS ITEM

Two cars collided at a junction: one car was travelling northward and the other southward. The driver of the southbound car claims that the northbound driver was overspeeding. The traffic police are not sure of who is at fault. A witness stated that the cars travelled together after the collision. One of the drivers was not wearing a seatbelt. To identify a vehicle which was over speeding or braking heavily before the crash, the risen tyre temperatures can provide physical temperature of the tyres as follows:

Length of the mercury thread when in contact with the tyre: 40cm

Length of the mercury thread at the ice point: 10 cm

Length of the mercury thread at the steam point : 80 cm

Additional information

- Mass of the car travelling northward: 2000Kg
- Mass of the car travelling southwards: 1800Kg
- Velocity of the car travelling southwards before the collision: 70Km/hr.
- Common velocity of the two cars after the collision: 35Km/hr.
- Speed limit on the road: 70Km/hr.

Task:

As a learner of physics,

- (a) Guide the police on whether the pickup was overspeeding.
- (b) Advise the driver who was not putting on the seat belt on how it can safe guard his live
- (c) Assist the police to get the correct tyre temperature.

LOWER SECONDARY PHYSICS ITEM

A parent had a small piece of land besides his main house. He decided to put up a two roomed rental for purpose of increasing on his average income. He however set the rentals directly below electric transmission power lines and installed one electric meter to be used by two different occupants of his rentals. Misunderstandings arose as it was not clear which occupant to pay how much of electric bills. It was however discovered that the two occupants used one inside bulb each of different rating and one common security bulb. It was further discovered that; Occupant of room no. 1 was using a flat iron rated 1000W for 30 minutes per day, TV rated 150W for four hours per day and a light bulb rated 7W for 5 hours per day.

Occupant of room no.2 was using a kettle rated 1500W for 40 minutes per day and a light bulb rated 10W for 5 hours per day.

The security light is rated 10W for 5 hours per day.

Hint; cost of one unit (1KWh = Ugshs. 504/=)

TASK

- (a) Prepare a sensitization message to this parent (land lord) and the community why they should not build under electric power lines over long distances.
- (b) Help the two different occupants each to understand how much of the total bill is supposed to pay in 30 days.
- (c) As a physics student advise the occupants on how they can save on the consumption of power.

LOWER SECONDARY PHYSICS ITEM

In a newly opened estate, the planner had a specified number of occupants for the estate and the electricity board gave them a transformer that could serve the specified number of occupants. However the number of occupants eventually increased beyond the planned number due to sub division of the plots and transformer could not serve the population any more. All people started to complain that there electrical appliances, security lights and security alarms are no longer working and this has brought insecurity in the estate Hint;

Power input of the transformer = 12000W, Voltage output = 240V and output current = 20A

Task

As a physics student;

- (a) Explain why the transformer could no longer serve the big population of the estate.
- (b) Suggest the possible causes of power losses in a transformer and how they can be minimized
- (c) Explain how an electric bell(security alarm) works in order to alert people

LOWER SECONDARY PHYSICS ITEM

A business man in the tourism sector in Uganda, intends to run an advertisement on a UK Television station in an attempt to boost the business. The business man has been informed that the advertisement that is run during the day in UK will be viewed at night in Uganda at the time it is run. For better insights into the Uganda tourism sector attractions, the business man has also been advised to have:

- Correspondent in Uganda who will report live and in real time whenever the advertisement runs.
- An efficient system that helps in the tracking of the tour guide vehicles. When the business man presented this idea to the staff, they were confused and wondered how night in UK is day time in Uganda, how a live broadcast in Uganda is possible to viewers in UK and how tracking of tour guide vehicles is likely to be achieved.

Task:

As a student of physics, you have been approached by the business man for help. Prepare a write up that will help the staff understand how their concerns arise and can be achieved so that the business proposal is adopted.

LOWER SECONDARY PHYSICS ITEM

“Out of nowhere, we heard like a thunderstorm” witness Jason Alas said. “It was like really, really loud”. “And all of a sudden, the building housing the offices was on fire burning.” “I really don’t understand what happened”. After the incident, Jason Alas donated a faulty loud speaker rated 108 W, 240 V for use in community mobilisation for building materials in an attempt to rebuild the burnt building. It was later discovered that the loud speaker needed a small size resistor that could allow a current not exceeding 13 A to function well again. Two darkened rods of iron and copper were also donated to help in safe guarding the building after reconstruction.

Task:

Help Jason Alas with:

- (a) All relevant information so that he understands what really happened.
- (b) The value resistance required to make the loud speaker function again.
- (c) How the new building can be safe guarded to prevent future occurrence of the same incident.

LOWER SECONDARY PHYSICS ITEM

During a news bulletin broad cast live at night from America, viewers watch from Uganda during day time on TV. The reporters show live images of an eclipse happening, which is something the viewers had never seen.

Task.

Use your knowledge of Physics to help the viewers understand;

- (a) Why it is day time where they are and night time on a live broad cast on TV?
- (b) What an eclipse is?
- (c) How it's possible for a live broadcast to happen in one country and be watched in another country?

LOWER SECONDARY PHYSICS ITEM

Students in a certain school are going for a trip in a mountainous area where the maximum height one is allowed to climb is 1km per day. They were allowed to have stop overs at specific points for various reasons. They had also been warned of the possibility of nose bleeding while climbing the mountain. Another group of students who had visited the same place earlier told them their first stop over was at a place B where a barometer reads 68.2cmHg, while it read 75.7cmHg at a place A which was going to be their starting point. The students were told that the cooking would be done at place A but they couldn't understand why that was so.

Task:

Use your knowledge of physics to help the students:

- (a) Determine if they will be allowed to climb beyond point B.
- (b) Identify when they were more likely to nosebleed.
- (c) To explain why the cooking had to be done at Point A.

LOWER SECONDARY PHYSICS ITEM

Eunice is required to bathe her younger brother James as instructed by her mother. According to the advice from the family doctor, the bath should be between 40°C and 42°C . Eunice has two litres of hot water at 100°C and 6litres of water at 20°C .Eunice has to do mixing in an Aluminium saucepan of mass 3.5kg and specific heat capacity $650\text{JKg}^{-1}\text{K}^{-1}$

Task;

As a learner of physics,

- (a). Help Eunice establish whether water is warm enough for James to bathe after mixing.
- (b). In what ways would you prevent the water from cooling very fast?

LOWER SECONDARY PHYSICS ITEM

A home owner was recently told electricity from a power substation is transmitted at 12 KV using thick aluminium 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.

Task: Use your knowledge of physics to;

- (a) Help the home owner understand how the electricity changes from 12 KV to 240V.
- (b) Why thick aluminium cables are used?
- (c) How the appliances should be connected to ensure that they work effectively with a high amount of current.

LOWER SECONDARY PHYSICS ITEM

The welders in a certain workshop are troubled with their tools being shocked by electricity from a generator of **240V**. When they visited a technician, they were advised to wind a copper wire to **3000** turns around a soft iron ring on the receiving part so as to output **120V** suitable for their work shop operations fixed in a box. However, the welders seem bothered of how this will be of help.

Task

As a learner of physics,

- (a) Explain to the welders how the above design will produce power corresponding to their consumption.
- (b) Help the welders to determine the number of turns to be wound on the output part of the device.
- (c) Comment on how efficient the device if the ratio of current output to current input is **1.5**.
- (d) Advise the welders on how to improve the efficiency of the device.

LOWER SECONDARY PHYSICS ITEM

In a certain cafe, space viewers were watching a YouTube live broadcast when an astrophysicist was conducting research from the International Space Station where he observed various weather patterns and human activities taking place during the day but found it challenging to gather data at night due to reduced visibility. The astrophysicist utilized a satellite orbiting Earth to maintain consistent data flow. The viewers were so excited about the relevancy of satellites in bridging the gap between day and night observations to allow data exchange. Some viewers commented that the International Space Station is a key in space exploration while others criticized the information they got that many countries invested a lot of resources to build the Space Station. The viewers questioned the source of energy being used by electrical gadgets like computers in the space station.

Task: As a physics learner, help the viewers understand;

- a) How satellites are relevant in space exploration.
- b) (i) Why countries invested a lot of resources in building the International Space Station.
(ii) The source of energy used in the International Space Station.
- c) The cause of reduced visibility that made it challenging to gather data at night.

LOWER SECONDARY PHYSICS ITEM

Upon embarking on a leisurely biking trip through a forest on a hot midday, the biker encountered a puzzling phenomenon in which something like a pool of water repeatedly appeared and disappeared in front of him as he rode along the tarmac road which affected his pace significantly. Unexpectedly, the biker noticed a tall building adjacent to the spot where the pool of water reappeared and recalled that echoes can be utilized to determine the exact distance between himself and the tall building where the pool of water mysteriously appeared again. He timed the echo of a sound, resulting in 0.9 seconds though he couldn't recall all the steps to determine the distance between himself and the tall building so that he can clear the confusion from the phenomena.

Hint: The speed of sound in air is 320m/s.

Task: As a student of Physics, assist the biker;

- a) Comprehend the peculiar occurrence of the disappearing pool of water.
- b) (i) Clarify the method to measure the distance using the sound echo.
 (ii) Understand why the tall building was necessary in determining the position where the pool of water reappeared.
- c) Know the actual position where phenomena reoccurred to confirm it's a mere illusion.

LOWER SECONDARY PHYSICS ITEM

The manager of a certain workshop that makes handcrafted wooden toys recently purchased a new machinery, rated $17\text{ V} \sim 20\text{ V}$. However, it did not function efficiently upon testing on a socket that supplies a voltage of 6 V . When the manufacturer was consulted, the manager was advised to purchase a transformer with 50 turns in the primary coil and 150 turns in the secondary coil to solve the problem of low voltage for the machinery without dissipating heat at a rate more than 19 W but, the manager was hesitant about the suggestion complaining that the manufacturer sold to him a malfunctioned machinery.

Hint: The machinery draws current of 1 A from the A.C source.

Assume the transformer is ideal (no energy losses).

Task:

Using the knowledge of physics, help the manager understand the manufacturers advise by;

- a) Computing the voltage expected across the secondary coil to be used by the machinery.
- b) Finding the rate at which the machinery will be heated.
- c) Explaining the structure and operation of the transformer recommended.

LOWER SECONDARY PHYSICS ITEM

In a certain factory, there are 10 electric motors operating at 80 % efficiency. These motors consume an average of 5 kW of power per hour. The factory runs for 8 hours a day, 5 days a week. The operators have raised concerns about the high-power consumption by the motors. However, the engineers have suggested upgrading to motors with 90 % efficiency, though the manager is hesitant due to concerns about wasting resources on new motors.

Hint: The cost of a unit of electricity is 1050/=

Task: As a student of Physics, help the manager;

- a) (i) Confirm the complaints raised by the operators while running the 10 electric motors in a week.
 - (ii) Know how much the factory spends on electricity to run the electric motors for a week.
- b) Understand that upgrading to more efficient motors can benefit the factory both financially and environmentally.
- b) Understand how an electric motor works and its importance in the production process.

LOWER SECONDARY PHYSICS ITEM

You are a nuclear physicist working at nuclear power plant. Your task is to ensure the safe operation of the plant and prevent any potential accidents or radiation leaks. One day you receive an alert about a potential malfunction in the reactor core. You quickly analyse the situation and realize that there is an increase in the rate of nuclear fission reactions within the core. To prevent a meltdown you propose using control rods made of a highly neutron absorbing material such as boron or cadmium.

These control rods will be inserted into the reactor core to absorb the excess neutrons, effectively reducing the rate of fission reactions. After implementing this you monitor reactors, temperature, and pressure and radiation levels to ensure stability.

- (a) You also conduct experiments and analyze atomic properties of different materials to find optimal conditions for safety.
- (b) Explain the dangers of radiation leaks and how they can be minimized
- (c) Explain how the process can be used in generation of electricity.

LOWER SECONDARY PHYSICS ITEM

A man attended a live concert of his favorite band at a large outdoor venue which was near from the tall building. He noticed sound of the band returning from the building and heard it after 6 seconds when original is produced. As the sun sets, the stage lights up with vibrant colors and the stage becomes the center of attention. The heavy bassline begins to thump through the speakers resonating throughout his body. The singer's powerful voice fills the air as the crowd erupts with excitement. As he decided to enclose the stage his color of clothing changed

Hint

The stage was illuminated with blue, green and red lights

The man was wearing yellow shirt with blue strips and cyan trouser

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

Task

As a learner of physics help the man to;

- (a) Determine the distance from the band to the tall building
- (b) Understand why the color of his clothing changed
- (c) Prepare a write up about applications of reflection of sound to the community

LOWER SECONDARY PHYSICS ITEM

One of the most misunderstood branches of physics for many years has been space physics (Astronomy). Some of the examples of such misunderstandings include the following. The Catholic Church at one time thought that other heavenly bodies, including the sun, orbited around the earth, rather than the earth. This was the problem that Catholic hierarchy had with Galileo. For example, the Church tried and arrested Galileo Galilei for supporting Sun-centered view of the universe.

While watching the world cup which took place in Brazil in 2014 at 9pm East African time, the football fans watching the game in East Africa realized that it was still daytime in Brazil, some of them were puzzled by this?

While it snows (winter) in most European countries in December around Christmas season, the people in East Africa have never seen any snow fall in East Africa and some of them wondered why it is this way?

Task, as a learner of physics,

Write a report to the community on enlightenment about these astronomical events in order to promote deeper understanding of physics in the school and community at large.

LOWER SECONDARY PHYSICS ITEM

An engineer and his employee had a disagreement on the best type of simple machine to use when raising the tank of weight 600N the top of a raised platform on a building of height 12m. the machines available were a block and tackle pulley system of velocity ratio 5 and 36 m long requiring an effort of 250N and an inclined plane 244 m long requiring an effort of 400N. the tank was to be used to supply cold water at 20⁰ c to the rooms of clients to mix it with hot water of 80⁰ c to attain the bathing temperature of water at 35⁰ c

Hint

Each heater in every room boils 2.5 liters of water
 Specific heat capacity of water is 4200J/kg/K
 Density of water 1000kg/m³

Task

As a learner of physics

- (a) Analysis the information and use it to settle the disagreement
- (b) Help the engineer to determine the amount of cold water that will be supplied to clients

LOWER SECONDARY PHYSICS ITEM

Conrad is required to prepare a bath for his younger brother Alex. According to the advice got from his mother, the bath should be between 40°c and 42°c . Conrad however has 2 liters of hot water at 100°c and 6 liters of cold water at 20°c . All that Conrad has to do is mixing in an aluminum pan of mass 3.5 kg and specific heat capacity 660J/kg/k .

Task; As a learner of physics

- a) Help Conrad to establish and inform his mother whether the water is warm enough for Alex to bath.
- b) In what ways would you prevent the water from cooling very fast
- c) Help Conrad to understand why water is used as a coolant in engines

Use

Density of water 1000kgm^{-3}

Specific heat capacity of water $4200\text{Jkg}^{-1}\text{K}^{-1}$ Acceleration due to gravity = 10ms^{-2}

LOWER SECONDARY PHYSICS ITEM

During an evening down pour, a sharp flash accompanied with loud sound were witnessed. As a result the whole village experienced a total blackout. Later it was discovered that a transformer had been damaged by the sharp flash. The village organized a meeting to solicit funds to purchase a new transformer. In attendance was the area Member of Parliament who promised the members that he was to purchase a device which can safeguard the transformer against other damages from such a flash. People wondered how the device can protect a transformer. After two weeks the funds were realized and a committee was selected to go to town and buy the new transformer. The transformer dealer presented to the committee a transformer which supplies 12 V when connected to 240 V mains supply and it takes a current of 1.1 A from the mains when used to light ten 12 V, 24W lamps in parallel. The convinced the buyers that the transformer had an efficiency of at least 96%. They were not sure of how the dealer arrived at the value.

Task

Using knowledge of physics,

- (a) Find out whether the trader was trustworthy when he stated the above value
- (b) Sensitize the community on how the device would safeguard the transformer against such destruction

LOWER SECONDARY PHYSICS ITEM

In a certain music concert that took place at night in a certain hotel on an Island, the artist played a guitar on a floating stage surrounded by disco lights flashing red, blue and green. The people in the audience were wearing yellow clothes with black spots on them. The audience was surprised about the new appearance of the colours of their clothes. The sound waves from the guitar travel through the air with a frequency of 440Hz . The organizers also projected laser light, which travels through air with a frequency of $4.7 \times 10^8\text{MHz}$ illuminating waves on the lake surface to aid visibility. The shores of the lake were 15m away from the hotel where performance was. Boys A and B standing on the lake shores in the same direction and in line with the playing music from the performance room in the hotel heard the sound at different intervals of time which attracted them to go and observe what was taking place at the Island. Boy A heard the sound after 3s and boy B heard the sound after 4s.

Hint:

Speed of light in air = $3.0 \times 10^8\text{ms}^{-1}$, Speed of sound in air = 330ms^{-1}

Task: As a physics student;

- Help the two boys to understand why they heard the sound at different intervals.
- Clearly explain why the colour of the clothes of the audience kept on changing when coloured lights flashed on them.
- Why was laser source of light preferred to provide laser light that enhanced visibility late in the late hours of the night.

LOWER SECONDARY PHYSICS ITEM

In a certain mine known for extracting copper and cobalt, as well as small amounts of uranium ore, the radioactive substance from the uranium ore had contaminated the storm water runoff from the mines, which locals were unknowingly using for their daily needs. This led to a health crisis in the community as people started experiencing symptoms of radiation poisoning. To address the situation, the factory was closed as a team of scientists was called to investigate the situation. The initial concentration of the radioactive substance in the storm water was measured to be 1000 millisieverts per liter.

Based on their research, the scientists discovered that the half-life of the radioactive substance was 50 years.

Hint:

Storm water will be safe for use if the concentration of the radioactive substance in the storm water is less than 16 millisieverts per liter

Task:

As a learner of Physics, help the locals understand;

- a) When the water will first be safe for consumption.
- c) The potential health risks for the individuals who had been exposed to the contaminated water.
- d) The safety precautions they should follow while dealing with those who have been affected.
- e) The impacts of the uranium ore contaminating the storm water runoff.

LOWER SECONDARY PHYSICS ITEM

One of the most misunderstood branches of physics for years has been space physics (Astronomy). Some of the examples of such misunderstandings include the following.

While watching the world cup which took place in Brazil in 2014 at 9:00 pm East African time, the football fans watching the game in E. Africa realized that it was still day time in Brazil, some of them were puzzled by this.

The NASA (National Aeronautic and Spaced Administration) tells us that the only planet that supports life is earth.

TASK:

- a) How can you explain the above statement in case one to your classmates, siblings or friends about the astronomical events in order to promote deeper understanding of physics in the school and community at large.
- b) The solar system is composed of big, small and much smaller objects including planets. All planets move around the sun in elliptical paths. The motion is both rotational and revolution. Rotation motion involves the planets spinning about a fixed axis and revolution motion involves planet moving around the sun.
 - i) Help us to identify the other components of the solar system.
 - ii) Draw diagrams to show rotational motion and revolution motion

LOWER SECONDARY PHYSICS ITEM

A steel and tube industries company limited was contacted by the school to make a number of new items to restock their kitchen. Among the items on the invoice are; saucepan, strainer, saucepan covers (lids), ladles, cups and plates for students. The school did not specify the type of materials these items should be made of and therefore, the procurement officer of the company their raw materials supplier and the following was supplied following the invoice.

Plain sheets of copper

Plain sheets of aluminum

Clay

Wood

Melamine resin powder

For the production team to come up with the items requested by the school, they have to subject these raw materials to either heat or force however these materials behave differently under these two factors.

Support knowledge.

Heat capacity of copper is $400 \text{ Jkg}^{-1}\text{K}^{-1}$

Heat capacity of aluminum is $900 \text{ Jkg}^{-1}\text{K}^{-1}$

Task

As a physics learner,

- a) With reason(s) help the production team to select the raw material suitable for each item to be produced.
- b) Explain at particle level how these materials behave when subjected to either heat or when a force is applied.

LOWER SECONDARY PHYSICS ITEM

A pump is used to fill a tank by drawing water from underground well to be used at school power house. In order to minimize on power consumption its use for limited time, the pump works at a constant rate of $2.4 \times 10^2 \text{W}$ and it's able to raise 0.188 m^3 of water every minute through a height of 6m. The cooks complain that it is slow at work. At the power house the cook is always surprised because water pumped in the morning is always above the normal temperature at 30°C when measured using a thermometer which the cook checks before making morning tea. The pump is said to be efficient if the ratio of its work out put to work input is above 0.75 and the cook boils 9.5l of water for morning tea and 500g evaporated.

Support materials

Density of water is 1000kgm^{-3}

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

Specific latent heat of vaporization of water $2.56 \times 10^6 \text{Jkg}^{-1}$

Task.

- (a) Obtain the rate at which the pump works in raising the water and comment on its efficiency.
- (b) Explain to the cooks why water pumped in the morning has such temperature.
- (c) How much heat is necessary to turn the lost volume of water into vapor.