535/1

PHYSICS

Paper 1

2024

2½ Hours

2024 MOCK ASSESMENTS

UGANDA CERTIFICATE OF EDUCATION PHYSICS

Paper 1

Theory

2 Hours 30 Minutes

INSTRUCTIONS TO CANDIDATES:

This paper has **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

1. Two boys who were watching a football match at 7:15 pm were surprised they could see the football players as compared to two months ago when it would be dark by 6:40 pm. The footballers also complained that for the last two months, it had been very hot with no rain which led to the drying of the grass in the field. The footballers were told by the boys that the weather could be accurately

predicted such that measures are taken to ensure their field does not dry up. The boys however left without explaining how it was done because it was late.

Use your knowledge of Physics to explain;

a. What led to the length of day time increasing as compared to other days?
b. What caused the dry season the area was experiencing?
c. To the footballers how weather can accurately be predicted.

2. A cancer patient was visited by one of his relatives. The relative was told she could not see her patient since a radioactive material of activity 425 counts per minute as read on a Geiger Muller Tube and a half-life of two days had just been applied to the patient. The relative of the patient demanded to know how long it would take before she was allowed to see the patient, the dangers associated with radioactive materials, and how they are kept and handled.

Support; Background radiation = 50 counts per second.

Use your knowledge of physics to;

a. Determine how much time it would take before she could see her sick relative.
b. Explain to the relative the dangers associated with radioactive materials.
c. Explain to the relative how such materials are handled.

3. During a visit to a laboratory, students observed a ripple tank of depth 60cm filled with water where modifications had been made to create a shallow end of depth 20cm. A circular rod vibrating at 80 Hz from the shallow end is made to produce ripples. To their surprise, the spacing between successive troughs changed from 4.5cm to 8.5cm, and the velocity of the ripples changed and distorted when they struck the tank walls. A stick that was in the tank appeared bent which scared the students.

Hint; The tank would crack if the velocity of the ripples exceeded 8 ms^{-1}

Use your knowledge of physics to:

a. Determine if the tank would crack.

b. Explain what caused the distortion of the waves and how to reduce it.

c. Explain to the students why the stick appeared bent.

SECTION B

PART 1

Answer only 1 question from this part.

4. Senior four students in a certain school are going for a trip in an area with muddy roads in two buses coloured white and black. The driver of one of the buses saw a police officer showing a hand signal for them to stop. The bus decelerated at 10 ms^{-2} and came to rest in 12s. The police officer complained about the drivers over speeding, loading luggage on their upper racks and about their tyres having no treads. The passengers in the black bus also complained about the bus being too hot inside. On checking, the temperature inside the black bus was 7 ºC higher than the white one

   Hint; The speed limit in the area where the policeman was standing was 60 kmh^{-1}

   Use your knowledge of physics to;

   a. Determine if the buses had exceeded the speed limit.
      Help the drivers understand why;
   b. The police officer complained about the luggage being loaded on the rack of the bus and the state of the tyres.
   c. There was a difference in temperatures between the two buses.

5. An aluminium pan of mass 800g and specific heat capacity of 800 $JKg^{-1}K^{-1}$ containing 1.5 kg of ice blocks at -10 ºC was accidentally put under a tap producing steam at 100 ºC by a house help. After a few minutes, the ice had all melted and the temperature of the water in the pan was 15 ºC. The house help was surprised by the disappearance of the ice cubes and was tasked to ensure the water did not become warmer without putting it in a refrigerator and to determine the increase in the mass of the contents of the saucepan.

   Use Latent Heat of Vaporization = 2.26×10^6 JKg^{-1}

   Latent Heat of Fusion = 3.4×10^5 JKg^{-1}

   Use your knowledge of physics to;

a. Determine how much steam was bubbled into the saucepan.
b. Explain what happened to the ice blocks
c. Suggest ways in which the water can be kept at that temperature for a long time.

PART 2

Answer only 1 question from this part.

6. A group of learners from a certain school visited a residence and were requested by a neighbour to press a switch by the door side. On pressing it, they heard a loud bell sound and the door was opened shortly afterwards. The learners were surprised when they were told it is an electric bell of 240V, 20W with a U-shaped piece of iron but couldn't explain how the bell works, what would happen if the bell was used in a house with a mains supply of 120V and how the sound of the bell can be increased.

Use your knowledge of physics to;

a. Explain how the electric bell works.
b. What would happen if the electric bell was moved to a house with a voltage of 120V?
c. Explain why the bell has a U-shaped piece of iron.
d. Suggest ways in which the sound of the bell can be increased.

7. A power source of emf 18 V is meant to be connected to appliances of 20 Ω and 40 Ω that operate on a 240 V main supply. The owner of the battery however doesn't know how to change the voltage of the battery and has been advised to use a transformer but he is ignorant of what that is. He also doesn't know how the appliances should be connected in a way that gives maximum current.

Use your knowledge of physics to;

a. Explain to the owner of the battery what a transformer is and how it will be used to change the voltage from 18V to 200V.
b. Advise with evidence on how the appliances should be connected such that maximum current flows in them.
c. Other benefits of connecting the appliances like in b. above.

END

SECTION A

Answer **all** the items from this section

1. With the intention of producing electricity by 2030, the Ugandan government is preparing to construct its first nuclear power station. The goal of this large-scale initiative is to meet the nation's increasing energy needs in a sustainable manner while lowering its dependency on fossil fuels. However, due to worries about the safety of nuclear power, there has been a lot of public criticism. Many people are unaware of the various benefits of nuclear energy and are concerned about the possibility of explosions if energy production is not controlled, the impact of background radiation on human health, and the long-term risks posed by radioactive waste with long half-lives.

   Task: A well-known local radio station has invited you as physics student to address the public's worries and provide an explanation of the science behind nuclear energy production in a nuclear reactor in a controlled way.

2. The science club at a Secondary School has initiated a national science literacy campaign. As part of this effort, they are hosting a series of outreaches aimed at primary school students to foster a better understanding of astrophysics and its relevance to everyday life. The focus of their discussions will include energy production in stars, the importance of the Sun's energy, the variation in stars' colours, the life cycles of stars, and the importance of space exploration.

   Task: As a student of physics, you have been requested by the school science club to deliver in one of the outreaches to primary school students. Your task is to educate them on

   (a) How the sun produces energy needed for live to survive?
   (b) the variation in colour and brightness of stars in the Milky way in terms of their size and distance from the earth
   (c) the different stages in the life cycle of a star
   (d) the purpose of the international station and its role in space exploration.

3. A new company has just been built next to your home, and while they have hired security guards, the security cameras they intended to purchase are currently out of stock. At the moment, they were looking for a basic tool that would enable them to view over the wall and what is outside when they are inside the perimeter fence. In addition, the company has been advised to install a laser rather than a regular lightbulb for nighttime security.

Hint;

- Available is a mirror and a glass prism.
- the laser chosen for the security system has a wavelength of $532 \times 10^{-9} m$.
- Speed of light in a vacuum is $3 \times 10^{8} ms^{-1}$
- Frequency of laser suitable for security system should be less than $6 \times 10^{14} Hz$.

Task: As a physics student:

(a) Choose between a mirror and a glass prism for the design of the simple instrument. Explain your choice with reasons and use a diagram to illustrate the design and operation of the simple instrument.

(b) Explain to the company how light from the regular light bulb is different from a laser and advise on whether the laser they purchased is suitable for their needs.

SECTION B
PART I

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

4. An ambulance is transporting critical medicine from the city Centre to an upcountry district. The medicine must be kept refrigerated, and the mini refrigerator in the ambulance is chargeable. However, the ambulance runs out of fuel, and the driver stops a passing pickup truck for help. The pickup truck driver offers to give some fuel, but when checking the battery, the ambulance driver realizes it is draining quickly. The refrigerator indicates it has only 3 hours of operational time left. The remaining distance to the destination is 150 km.

   The only method they can use to get fuel from the pickup is through a pipe.

   The amount of thermal energy required to maintain the refrigerator's internal temperature should be higher that than 450000J

   Task: As a learner of physics, you have been requested to;

   (a) Explain using diagram how the driver can get fuel using a pipe from the pick-up truck to his tank.

   (b) Advise the driver on the minimum average speed the driver needs to maintain to ensure the medicine remains properly refrigerated upon arrival.

(c) Establish whether there is enough energy to maintain the refrigerator's internal temperature if the refrigerator's power rating is 50 W.

5. Two cars collided at a junction: one car was traveling northward and the other southward. The driver of the southbound car claims that the northbound driver was over speeding. 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 evidence. The police used an uncalibrated thermometer to measure the 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: 10cm
   Length of the mercury thread at the steam point: 80cm

   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 this road: 70km/hr.

   Task: As a learner of physics,

   (a) Guide the police on whether the pickup was over speeding.

   (b) Advise the driver who was not putting on the seat belt on how it can safeguard his live

   (c) Assist the police to get the correct tyre temperature.

PART II

Answer **one** item from this part

6. A building has been struck by lightning, causing damage to its electrical system, including a fuse, a copper wire used as an earth connection, and a small transformer that was functioning as a voltage regulator. The building's owner has decided to replace only the transformer for now and plans to address the fuse and earth connection later. However, he is uncertain if the newly purchased transformer will perform adequately. The previous transformer had a power

output of over 80W. The building owner has also refused to install a lightning conductor.

Hint:

- The new transformer is designed to work on a 240V, 60W supply. Primary coil has 300 turns and secondary coil has 200 turns and its efficiency is 80%

Task; As a student of physics, you been requested to explain to the owner of the building

(a) How installing a lightening will protect his building

(b) Whether the newly bought transformer is suitable for the building's needs

(c) the dangers associated with delaying the replacement of the fuse and the re-establishment of a proper earth connection.

7. A business person has started a large-scale business and wants to understand his daily power usage. He also needs guidance on choosing a generator, saving power, and ensuring his workers are knowledgeable about wiring and maintenance. He has the following electrical instruments.
12 security bulbs (5W each) operating for 12 hours a day
A 65W refrigerator operating for 24 hours a day
A 3000W juice making machine operating for 5 hours a day

Tasks: As a student of physics, you have been requested to;

(a) assist him to know his daily power usage from the listed electrical instruments

(b) choose a suitable generator for his business needs and explain the operation of the chosen generator with a labelled diagram.

(c) Describe to his workers the insulator colour codes used in domestic wiring.

(d) Provide suggestions on how he can save energy.

THE END

SECTION A

ITEM 1

A certain man went for tooth extraction in a clinic with his 8-year-old son. The dentist was so busy and so asked his nurse to look for an optical instrument of radius of curvature 20cm, that this would give him the best magnification.
The average length of a mature human tooth is 3cm.
To achieve the best results, the nurse was advised to have a tooth 15cm from the instrument.
As soon as they arrived home late in the evening, the 8-year-old son started narrating to his siblings and their mother and the neighbors in the next room who had closed their room to sleep heard the conversation. The neighbor felt sorry to the man.

HINT

Available optical instruments were 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 8-year-old boy in the other room.

ITEM 2

In a certain trading centre, the pressure of water in taps have seriously reduced and in some parts of the town, water is completely not there. This has worried locals around that town. Local authorities have been consulted to check whether there is any problem with underground water supply system in pipes before the issue is reported for further management.

Radioactive source	Radiation emitted	Half life	Solubility in water
P	α	22 hours	Low
Q	β	36days	Medium
R	β	15hours	High
S	γ	25minutes	High

Detector
Spart counter
Cloud chamber
Geiger muller tube

Counter
Scaler or rate meter

Task.

As a learner of physics;

a) Help the local authorities to choose from the table the appropriate materials they would use to report the issue of low pressure in the taps.
b) Sensitize locals of the town the likely method to detect the location of leakage in pipes with reasons.

ITEM 3

S.3 and S.4 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 to parents most of whom are peasants on a visitation day.

In the 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 supplemented that seasons are brought about by the motion of the planets about the sun and this distorts climatic conditions.

The audience got confused of 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.

Chairperson tasked each participant to make more research so that they can have clear information in 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.

SECTION B. PART I

ITEM 4

A certain high way restaurant in one of the towns in Uganda is known to provide warm water to its customers for washing hands.
An attendant who works in this hotel was given two similar plastic cylindrical tanks each with a cross-sectional area of $18380cm^2$ and height of 5.5m. One of the tanks is painted white and the other painted black.

Attendant is supposed to store $10m^3$ of warm water in any of the tanks. She is worried on which tank she can use to keep water and accommodate all the available water.

To ensure smartness in the restaurant, each tank is supposed to be supported on plastic stands as shown in the figure,

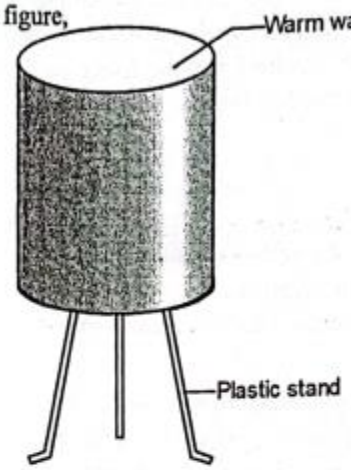


Fig. 1

Task

As a learner of physics,

a) Help to explain to the attendant on;
   i) The tank she would use to store the required amount of water.
   ii) The type of tank that would keep water for customers at required temperature.

b) If one of the tanks was to be used for hand washing and the owner of restaurant wants to put a tap on it,
   i) Show him by letter K, the position where the tap can be put.
   ii) Explain to the restaurant owner on the choice of position K.

c) What advice would you give to the restaurant owner on the measures he would ensure for the tank stand to withstand weight of the tank for a long time.

ITEM 5

While driving passengers, a taxi driver got frightened when a flying bird hit the wind screen. He then suddenly applied breaks and stopped that led the car tyres to burst and the passengers were seen to jark forward and backward.

As soon as the driver went out of the vehicle to check what had happened, he touched on the cover of the engine part of the car (bonnet) and it was so hot. On opening the bonnet, it was not in contact with the engine yet the engine was also hot.

The figure shows the motion of the vehicle before all this happened.

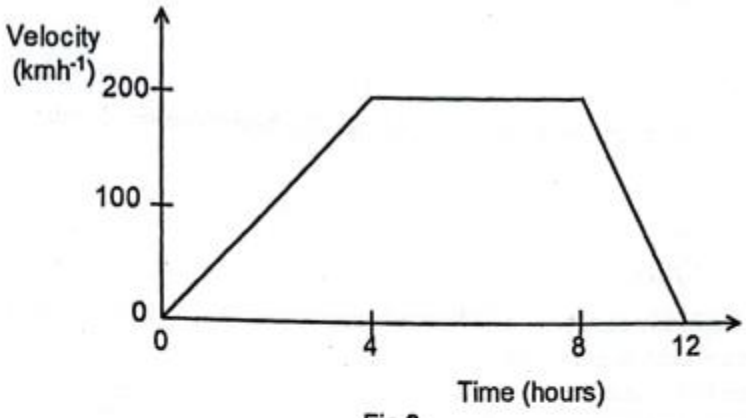


Fig.2

The taxi driver did not know the exact location he was, so that he could direct the mechanic to bring him new tyres to replace the burst tyres.

Task.

a) Help to tell why passengers had to jack forward and backward when the driver suddenly braked.
b) Help the driver to explain why the bonnet was so hot when he touched it.
c) Advise the taxi driver to direct the mechanic the exact location he would find him so he could deliver the new tyres.

PART II

ITEM 6

A certain home has three rooms each with a bulb as shown in the figure.

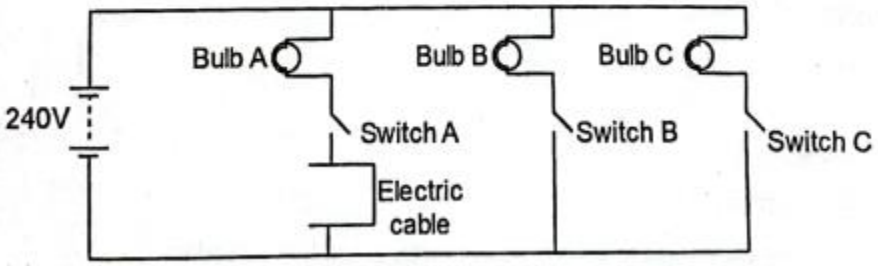


Fig.3

When all bulbs were switched on by members of the rooms at ago to have light, one bulb A did not light but the other two were found lighting brightly.
Bulb A and the kettle were put in the other rooms and the bulb light brightly as other two. The kettle is considered effective if it is switched on for 4 minutes and 8 seconds.

A member argued that energy from the transformer was not enough. Other members were confused because they do not know a transformer.
To ascertain all this, 1 litre of water is filled in the kettle at 15^0C and heated up to 100^0C.

HINT

Resistance of heating coil of the kettle = 40Ω specific heat capacity of water = $4200Jk^{-1}kg^{-1}$

Task.

As a learner of physics

a) Help the family members to understand why the two rooms had light when it was not lighting in the other room.
b) Explain to the home owner what a transformer is and how it works.
c) Advise the members whether the kettle was okay or it had a problem.

ITEM 7

A certain woman switched on a blender to prepare passion juice but it could not work. Her friend who had experienced a similar challenge told her that it was likely to be a Dc motor with mechanical problem that needed replacement. She had no money neither did she know what a DC motor was and how it worked. Soon as she was still complaining the electricity distribution company brought her a bill of 38,950.0shs for the last month of 30days which she disagreed with that it was too high compared to what she expected to have used.

Appliance	No. of appliances	Power(w)	Time
Flat iron	1	75	1 hour
Tv	2	100	4 hours
Phone charger	2	50	55 minutes
Lighting bulbs	4	50	2 hours

HINT.

Mains supply p.d = 240v
Cost per units = 950/=

Task.

As a learner of physics.

a) Help the woman to explain what a motor is and how it works.
b) Advise the woman so that she can appreciate the bill brought to her by electricity distribution company.

END

SECTION A
Answer all the items from this section

ITEM 1

A student putting on a blue shirt and a yellow trouser stand between two vertical walls. He makes a loud sound while seeking for help. He hears the first echo after 2 seconds and the second echo after a further 3 seconds. Three members of the rescue team arrived to help. Each of them had a torch producing red, green and white light. The colors of his shirt and trouser changed when light was shone on him at a time. This brought confusion among these students.

Hint: speed of sound in air = $330ms^{-1}$.

Task

As a learner of physics, help these students to understand;

(a) The origin of the two echoes.

(b) The distance between the walls.

(c) Why the color of the student's clothes changed when colored lights flashed on them.

ITEM 2

An archeologist discovered a material in the field. He got the sample of it which was monitored using a Geiger muller tube and the following data was obtained.

Count rate (counts per minute)	800	500	350	200	80	25
Time (minutes)	0.0	1.0	1.8	3.0	5.0	7.5

He did not know if this material was radioactive until he got the above data. He had just handled the sample with bare hands thinking it was safe.

Task

As a physics student;

a) Help the archeologist to know the half-life of the material.

b) Help the archeologist to know the possible health hazards he is likely to face since he handled the sample with bare hands.

c) Advise the archeologist on how to handle such materials in future.

ITEM 3

In 2014, Brazil hosted FIFA world cup where different countries participated in the tournament. Some countries such as Uganda did not qualify for the tournament and hence had to watch the matches live on their TV screens. In one of the games, it was evident that it was day time in Brazil yet in Uganda it was night time which puzzled John as he was watching the game live on TV, during the same period of world cup tournament (12^{th} June to 13^{th} July of 2014) it was winter in Brazil which weather affected some of the participant nations in the tournament.

More support information

At John's home there was a satellite DSTV dish.

Task

Using physics knowledge;

a) Help John understand the cause of night in one country for which it can be daytime in another country.

b) Explain the cause of variations in seasons.
c) Explain how communication was possible in this situation.

SECTION B
PART I
Attempt one item from this part

ITEM 4

A young man is planning to build his first house in life. He has no experience in construction work. He approaches an engineer who recommends him to buy the following materials for the foundation of the house:

- Steel bars (Hollow type)
- Dump proof course
- Clay bricks
- Cement
- Gravel

After construction of the foundation, he has to hire a casual worker who uses a force of 80N to push 50kg of soil along a piece of timbre which is 15m long to fill the foundation with soil. The height of the foundation is 2m from ground. The young man complains that these materials are many and some of them should be removed.

Using the knowledge of physics.

a) Explain to the young man why
   (i) Damp proof course is important in this work.
   (ii) Hollow steel bars are necessary
b) Advise the man on how the foundation should be made stronger and stable.
c) Determine the efficiency of the system used to fill the foundation with soil.

ITEM 5

A person has hosted five visitors at his home who are to stay for a night. He has started the process of preparing warm water for bathing. He has an electric kettle of capacity 5 litres. He switches on the electrical heater plugged in the kettle at its bottom and waits until water boils at 100^0C.then the heater switches off automatically. He now mixes this hot water with 20litres of cold water initially at 10^0C.

Support

Density of water = $1000kgm^{-3}$
Specific heat capacity of water = $4200Jkg^{-1}K^{-1}$

Task

As a physics learner;
(a) Advise the host if the temperature of the mixed water is not too high for water to burn the visitors given that the best bathing water should be at 15^0C.
(b) Suggest the number of liters to be used by each visitor if all of them are to use the same quantity of mixed water.
(c) Advise the person on how to keep this mixed water warm for a long time since all the visitors are to use the same bathroom one at a time. Explain your answer.

PART II

Attempt one item from this part

ITEM 6

A person wants to know how much money he should pay monthly after using the following appliances in his home. He has an electrical iron rated 240V, 1000W, a television set rated 240V, 50W, a fridge rated 240V, 100W and two computers each rated 240V, 50W. He switches on the appliances for two hours daily at once. He has to determine the size of the circuit breaker needed to keep these appliances safe.

Support: A unit of electricity costs Ugandan Shs.500

Task

As a physics student;

(a) Help the person to know his monthly bill

(b) Help the person to know the size of the circuit breaker needed and its importance

(c) Advise the best way of connecting the appliances for optimal use

ITEM 7

Small metal pieces are dangerous to be eaten by human beings. However, most of the ground nuts paste on market contain small pieces of these metals from old grinding machines made of iron. Each family is advised to have a mechanism of removing these metallic pieces.

Hint

You are provided with a nail, connecting wires of total resistance $1.6\,\Omega$, 2 dry cells each of e.m.f 1.5V and internal resistance $0.2\,\Omega$, a double cell holder and an insulated copper wire.

Task

As a physics student;

(a) Set up a mechanism for sorting the iron pieces from ground nuts.

(b) Comment on the effectiveness of the designed set up given that current of 2A is enough to create a strong magnet.

(c) Suggest how you can make this magnet stronger.

END

1. The students in a particular class visited a laboratory with a white bulb and a red one, to observe a glass tank filled with water with a white base at the bottom. Modifications were made to create a shallow end on one side of the tank using glass material. To their surprise, when they struck the water's surface at the shallow end with a long rectangular rod at a frequency of 80 Hz, they noticed that the spacing between successive crests changed from 2.5cm to 5cm. Additionally, they were disturbed by the distortion of ripples as they struck the tank walls. They were also surprised to see the base turning black when it was replaced with a yellow sheet and the red lights switched on.

Hint; the glass tank would break if the velocity of the waves that hit it is greater than 20 ms^{-1}

Use your knowledge of physics to:

a. Determine if the ripple tank will break.
b. Explain the reason for the change in the distance between the ripples and its impact on the velocity of the ripples.
c. Explain what distorted the waves and how it could have been reduced.
d. Explain why the yellow sheet changed color when the red lights were switched on.

SATTELLITES AND COMMUNICATION

2. An article in the newspaper gave information that on 2nd December 2022, Ugandan engineers with the help of Japanese engineers launched a satellite. The literature teacher who picked interest in the article found new words like artificial and natural satellites. He developed a number of unanswered questions which could be answered by a physics learner like you.

(a) Explain the difference between the two types of satellites in the article.
(b) With reasons, justify why Uganda should spend all that much money to launch its own satellite.
(c) Incase Uganda is to develop a super rocket capable of reaching different planets. List with reasons the planets it can land on and planets it cannot land on.

MODERN PHYSICS

3. The government has discovered a precious and rare mineral in a certain part of the country. A team of men picked samples and kept them in a store of one of the hospitals where photographic plates are also stored. The mineral was checked on regularly and they made the following observations;

- All photographic plates had darkened.
- Its mass reduced spontaneously with time as shown below

Mass (g)	200	150	70	35	25
Time (days)	0	4	16	28	30

As a physics learner,

(a) Support the view that the mineral is radioactive.
(b) Use the graph to estimate its half-life
(c) Explain the best way of storing this rare mineral.
(d) What are the dangers of exposing this mineral to the public

4. Workers at a construction site are meant to raise pieces of scrap of mass 6 kg through a height of 15m. Their boss always complains that the workers who carry the pieces of metal do the work slowly, especially in the afternoon when the temperatures are high and in the morning when it is cold. In response, the workers claim their hands are burnt by the hot metals which slows them down. One of the workers suggested they use a pulley of velocity ratio 4 and an efficiency of 80%.

   Use your knowledge of physics to;

a. Explain why the metals are very cold in the morning and hot in the afternoon.
b. Draw a design of the required pulley and explain how it can be used to solve their problem.
c. Determine the minimum force required to ensure an 80% is achieved.

   The string they used had a mass of 120g and a specific heat capacity of 2510 $JKg^{-1}K^{-1}$, and the work done to lift the load would be converted to heat energy in the string at the contact point of the pulley.

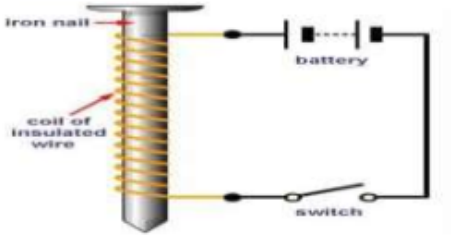
   Hint; The string would break if its temperature reaches by 28°C.

d. Determine if the string suggested above would be suitable for the purpose.
e. Suggest ways in which the efficiency of the pulley system can be improved.

5. During a party, 2 liters of water at 24 °C were served to a man and a woman. They complained that it was warm and were given 50g of ice at -10 °C blocks. They mixed the water and blocks in a wooden container with a negligible specific heat capacity. They were surprised by the ice cubes disappearing in the water. The man put his mixture in a plastic container **(shc = 2800 $JKg^{-1}K^{-1}$)** while the woman put her mixture in a metallic container **(shc = 800 $JKg^{-1}K^{-1}$)**. They were surprised to find their water at different temperatures after some time.
   Specific Heat capacity of water = 4200 $JKg^{-1}K^{-1}$
   Latent heat of fusion of ice = 340000 JKg^{-1}
   Use your knowledge of Physics to;
a. Determine if the water cooled when mixed with ice.
b. Why do the ice cubes disappear when mixed with water?
c. Explain why there was a difference in temperatures in the water kept in the plastic and the metallic container.

Part II
ELECTRICITY AND MAGNETISM.

6. An electromagnet as shown in Figure below is constructed by winding a wire around an iron nail of resistance 0.5Ω, connecting it to a battery of four cells of EMF 1.5V each, and then placing it above a tin containing iron fillings, some of which are attracted to the nail. Upon disconnecting the battery, most iron fillings fall off. However, when the iron nail is replaced with an identical steel nail of the same size, the pins are attracted slower. Surprisingly, when the EMF source is disconnected, just a few of the iron fillings fall off.



Use your physics knowledge to:

a. Explain how the electromagnet operates.
b. Use domain theory to explain how the nail becomes a magnet.
c. Elaborate on the difference in the time taken before the steel and iron nails start attracting small pins.
d. Explain what would happen if a battery of 2 cells of the same EMF was used instead of one of 4 cells.
e. Identify other factors that could contribute to an increase in the number of nails being attracted.
f. Suggest ways in which the magnetized nails can be made to lose their magnetism.

7. A certain household has a set of appliances as listed in the table below.

Appliance	**Power rating**	**Time of use**
4 bulbs	20 W each	13 hours every day
Cooker	2500 W	4 hours every day
Flat iron	1500 W	5 hours each week
Electric fence of low resistance wire	2200 W	10 hours every day

The owner of the household while making a budget for how much money would be required every week to cater for the electricity bill. He also wondered how the sockets for those appliances should be connected to ensure high current flows and why low resistance instead of high resistance wire is used.

Hint; The owner only intends to spend sh.50000 on electricity every week.

Use your knowledge of Physics to;

a. Determine if sh. 50000 would be enough to cater for the electricity bill for a week.
b. Explain how the sockets of the appliances should be connected to ensure maximum current flows
c. Explain why low-resistance wires are used for the electric fence.
d. Suggest measures on how to reduce the electricity bill.

END

Item 1

Joyce while playing, placed a pencil slanting in a glass of height 9.6cm high with one end of the pencil touching the bottom. On pouring water into the glass up to height of 8.2cm, the pencil appeared bent to her with the pencil's lower end raised by 2.05cm. She got confused since the pencil was originally straight before pouring water into the glass. Different colours were seen coming from the portion of the pencil in water. She decided to ignore the pencil in water and went back home. Along the way she observed a rainbow and thought that God is planning to punish the world since it was originating from heaven and entering the earth at two points.

Task:

As Physics student;

(a)Explain to Joyce why the pencil appeared bent and calculate the refractive index of water.

(b)Explain the origin of colours on the rainbow.

(c)Help Joyce with incidences where the phenomenon in the item above is beneficial to human life.

Item 2

Developed countries have a tendency of invading one another using dangerous weapons that may cause long term effects like cancer. These weapons cause mass destruction since they contain radioactive isotopes of Uranium with a half-life of 70 years.

Task:

(a)Explain how the long term effect above can be destroyed in a suspected part of the body.

(b) If a bomb of containing 800g of isotope was dropped in a certain city, for how long would the radiations reduce to $\frac{1}{16}$ of the original amount.

(c) How would you advise your government to use the above energy from radio isotopes to generate electric energy instead of making dangerous weapons?

ITEM 3

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

→ The Africans in the old traditions knew that the sun orbits the earth, rather than the earth orbiting the sun.

→ 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 day time in Brazil and they were puzzled.

→ 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 are always wondering.

Hint:

Task:

a) How can you explain the above cases to your friends who need enlightenment about these astronomical events in order to promote deeper understanding of physics in the school and community at large.

b) Explain how the football game matches were transmitted from Brazil to any East African country.

Item 4

At a certain Seed school located in a remote village, school dependents are required to participate and work on the ongoing school projects. During the December holidays the school resumed works of constructing a storied classroom block. John and Peter were tasked to carry bricks from the ground floor to the second floor that was being worked on. The task was tiresome by carrying bricks on their heads. After few hours John developed an idea of simplifying work by using a wheel barrow and an inclined plane. Later Peter sought of another idea of developing a single machine for raising the bricks vertically. When Peter looked in the vicinity, he realized that there was a motorcycle wheel, long ropes, straight poles, tall enough to reach the position where the bricks were to be put, and a large hemispherical pan.

Tasks

(a) Make a brief explanation on how John's machine was able to simplify work.

(b) Show how Peter could assemble the items to come up with a simple machine and how he would use it to lift the building materials up to the second floor in the shortest time possible.

Item 5

A chicken farmer rearing chicken on a commercial scale discovered that one-day old chicks are always vulnerable to extreme temperatures. In order for the farmer to be able to detect the level of temperature change, he approached his technician friend who designed for him a thermometer with no calibrations.

Task:

(a) Suggest and explain the possible causes of extreme coldness in the chicken house.

(b) Explain what the farmer should do to maintain the required temperatures in the chicken house.

Item 6

John collects scrap in Masaka city which he normally sells to Musoke who delivers the scrap to steel milling factory. The factory produces iron bars but the scrap consists of many metallic types. The officials at the factory only want to buy iron pieces of scrap. Musoke remembered that he can sort out iron pieces from the scrap using a magnet.

Hint:

An iron bar, insulated connecting wires of resistance 0.75Ω, four dry cells each of 1.5V are available to Musoke.

Task:

As a Physics student;

(a) Help Musoke to remove the pieces of iron from the scrap.

(b) Comment on the effectiveness of what you have designed, given that current of 6.0A is enough to create a strong magnet.

(c) Explain how the strength of a magnet created by Musoke can be increased

Item 7

During preparation for the function or party at your school, two decorators disagreed on the right way of connecting the coloured bulbs rate 240V to form a flood lamp operating on a fuse of 2.5A. The source of electromotive force being one of the school alternating current generators of maximum power output 1200W. The Headteacher is willing to allow the decorators use a half of the total power from the generator.

Task:

As a student completing a year course in Physics and using a simple diagram,

(a) Explain to the decorators how the generator operates. Comment on the major sources of power losses.

(b) Explain how the bulbs should be connected and how many are likely to be used.

Item 1

The manager of a certain store is faced with several challenges as highlighted below.

- Drinks from the fridge keep getting stolen. Initially, he could see the fridge directly but it was covered by a shelf. The manager could not afford to install cameras because of their cost.
- The manager could see near objects clearly but whenever he looked at an object that was far, it was unclear.
- Music played from a nearby bar was very loud. The sound was more disturbing at night than during the day. The owners of the bar claimed that their speakers produced sound waves of wavelength 1 cm which they thought was not harmful to anyone's ears.

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

  Use your knowledge of Physics to;

  (a) Identify which measures the manager of the store could take to be able to view the fridge.

  (b) Explain why the manager of the store could not see far objects clearly and what he could do to improve his vision.

  (c) Determine if the sound from the bar was harmful to the ears of those in the store, and explain why the sound was louder at night than during the day.

Item 2

Students were told to research on the construction of a nuclear power plant to provide a cheaper source of electricity. They discovered that a radioactive element, Uranium was used and it reacted as shown below;

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{139}_{56}Ba + {}^{95}_{b}Kr + 2{}^{1}_{0}n$$

The students however couldn't tell; if one of the products was an isotope of an element with an atomic number 36, which conditions are required for that reaction to successfully take place; other benefits of radioactivity, and how radioactive materials are handled.

Use your knowledge of Physics to;

(a) To determine if Krypton is an isotope of an element with an atomic number of 36.

(b) Identify which conditions are necessary for the reaction to take place successfully and precautions that should be taken when handling such materials.

(c) Identify other benefits of radioactive materials.

Item 3

A man who stays in an area with a view of the ocean requested his mother to pay him a visit to Canada. On her arrival at her son's home, it was noon, but her watch set to Ugandan time read 8:00 pm. On looking through the window, she also noticed very high waves in the ocean which was different from the photos that were always sent to her.

The mother called you to confirm if it was indeed night in Uganda while it was daytime in Canada.

Task

As a Physics student, explain to the mother;

(a) why it was night in Uganda and daytime in Canada?

(b) the cause of the high waves in the sea.

(c) how a person in Canada is able to make a phone call to Uganda.

SECTION B

PART I

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

Item 4

A man set off for a destination 250 km away from his home at 4:00 am to be at his workplace at 8:00 am. The speed limit on that road is 80 kmh^{-1}. He set off on the journey without fastening his seatbelt and drove at an average of 60 kmh^{-1} for the first 2 hours. He saw a truck that had fallen covering the whole road and stepped on his brakes which brought the car to a sudden stop. This made him jerk forward almost crushing into his windscreen.

The man stopped for 45 minutes and resumed his journey, reaching his workplace on time. He got out of his car and discovered it was very cold so he decided to wear a black sweater which was against the choice of his workmates who said he looked smart in his white shirt.

Use your knowledge of Physics to;

(a) Determine if the driver exceeded the recommended speed limit.

(b) Explain what made the man jerk forward.

(c) Explain to the man's workmates why he chose a black sweater.

Item 5

During a dry season, a school resorted to drawing water from an underground well 8 m deep. Originally, they did it manually by lifting a metallic bucket of mass 4 kg and volume 20 liters. The school workers however complained that the bucket was very cold in the morning, very hot in the afternoon when the sun was up. It was also very tiring to keep pulling up the bucket manually. They suggested a pulley system of 4 wheels and an efficiency of 80 % be used to help them work quicker. None of them could however tell how the pulley works and how much effort would be required to raise the bucket.

Hint; Acceleration due to gravity = 10 ms^{-2}

Use your knowledge of physics to;

(a) Explain what makes the bucket very cold in the morning and hot when the sun is up?

(b) Show what the pulley system suggested above looks like and how it works.

(c) Determine if a force of 5 N will be enough to give the pulley system an efficiency of 80 %.

(d) Suggest ways in which the efficiency of the pulley system above can be improved.

Turn Over

Item 6

A certain landlord recently finished constructing a block of 2 houses and consulted an electrician to connect the houses to the electricity grid. The electrician informed him that the voltage of the electricity needed to be stepped down from 13 kV to 240 V before connecting the houses. The landlord thought the electrician wanted to cheat him so he decided to hire another person who was not qualified to do the job since he was cheaper. The houses were connected in a way that a breakdown in one house could affect all the houses. The tenants complained that the current was so low and some of their appliances could not work. The tenants have threatened to vacate the houses if he doesn't work on the problem. Given that the appliances in the houses are connected such that the effective resistances in the houses are 10 Ω and 12 Ω.

Use your knowledge of Physics to;

(a) Explain to the landlord why stepping down voltage is required and how it is done.

(b) Explain to the landlord the cause of the low current in the houses.

(c) Show with evidence the modifications that could be made to ensure more current flows in the houses.

Item 7

A household with various appliances **(a 3500 W cooker used for 4 hours daily, ten 60 W lights used for 10 hours daily, and a 2500 W water heater used for 30 minutes daily)** is connected to a 240 V mains supply. The owner struggles to estimate the monthly bill and is uncertain about why an electrician insisted on the heater being connected to a fuse. **Hint; The cost of one unit of electricity = Ush. 800**

Use your knowledge of physics to:

(a) Determine if 65,000/- will be enough for the monthly electricity bill.

(b) Recommend whether the appliances should be connected in parallel or in series for better functionality.

(c) Explain why the heater should be connected to a fuse and how it works.

END

Item 1.

Consider your school to be organizing an annual Music, Dance, and Drama (*MDD*) event. To accommodate the large number of spectators, the MDD committee has been tasked with building a stage in the school compound. The MDD stage is to be positioned adjacent to the main hall, to minimize interference of echoes. To ensure optimal stage location, the committee is advised to use a parabolic mirror to focus a laser beam from the proposed stage position to the main hall wall to check for echoes. Additionally, they need to decorate the stage with unique sources of light. However, the committee members are not familiar with some of these tasks and seek your assistance.

Task:

As a physics student, help the committee;

(a) Explain how echoes are formed and why it's important to avoid them during such performances.

(b) To avoid interference of echoes, guide the committee on whether the selected position is a perfect spot for the stage.

(c) Explain why a laser beam should be preferred to the ordinary light in determining distance for the most appropriate echo free stage position.

(d) Describe the setup of a parabolic mirror and how it is used to focus a laser beam.

(e) Explain how a yellow dress with blue spots will appear while on stage when the red light is shone on it.

Hint:

(i) Speed of sound in air = 330 ms^{-1}

*(ii) During the testing, sound from the laser source took **0.16s** to make **one** roundtrip.*

(iii) Stage has been decorated with a source of red light.

Item 2.

Recently, your female friend enrolled in an Astrophysics course in one of the outside countries. After a few days of settling in, she called her parents in Uganda by 9am local time in that country. However, in Uganda, it was 8pm. Her parents had just received the news that the crescent moon had been sighted using the satellite communication, indicating the start of fasting of the holy month. During the phone conversation, she mentioned that her first lecture was about the life cycle of a star. This interested the parents who wondered how a star could have a life cycle and were also curious about the significant time difference between the two countries. The parents seek your explanation about these events.

Task:

As a physics student, help the parents to understand;

(a) What causes the differences in time such that in the country of study is 9am *(day time)* and Uganda is 8pm (night time).

(b) The crescent moon sighted is believed to have phases; Explain the phases regarding the new moon to full moon.

(c) Briefly describe the life cycle of a star.

(d) During satellite's communication, a combination of logic gates are used to encode and decode messages. For example, an **OR** gate combines two signals, **A** and **B**. If the output of the **OR** gate is true, the satellite transmits a signal back to the Earth otherwise, it does not. Basing on the conditions described, explain whether the satellite will transmit a signal back to the Earth if **A** is false (logic **0**) and **B** is true (logic **1**)?

Hint:

*(Include a truth table for the **OR** gate in your response.)*

Item 3.

It is established that a dairy company produces regular pasteurized milk that contains harmful bacteria. To ensure the effectiveness of the pasteurization process and monitor bacterial growth, the company adds a radioactive isotope tracer, Phosphorus-32 (P-32) to the milk. The tracer helps in tracking and ensuring that the bacterias are destroyed during pasteurization process. However, P-32 is harmful for human consumption until its activity is reduced to a safe level. To monitor the activity of P-32 in the milk to safe levels, the company uses a Geiger-Muller (**GM**) tube to measure the activity over time. The results obtained from the GM tube measurements are given in **table 1**.

Table 1: GM tube measurements.

Activity / counts per minute	22000	16000	11400	8200	5800	4000	3000	2400
Time (days)	0	2	4	6	8	10	12	14

Task:

As a physics student:

(a) Help the company by calculating the period to determine when the milk will be safe for human consumption.

(b) Write an advisory note to educate the company on the dangers of exposing themselves to radioactive substances and suggest any safety precautions that should be put into consideration.

(c) Traces of radiations are still found in the milk even though there is no source. This is attributed to background radiations. Explain the concept of background radiations and suggest their common sources.

(d) The **GM** tube can efficiently detect cathode rays but fails to accurately detect X-rays. Explain any **three** differences between Cathode rays and X rays.

Hint:

*(i) Phosphorus becomes inactive after its activity goes below **6000** counts per minute.*

Item 4.

A community leader who owns a popular village video cinema, is preparing for the upcoming power blackouts during the scheduled maintainace of the area transformer. To ensure uninterrupted entertainment for the villagers, the leader has invested in a diesel-powered **AC** generator **(Figure 1)** as a reliable backup power source.

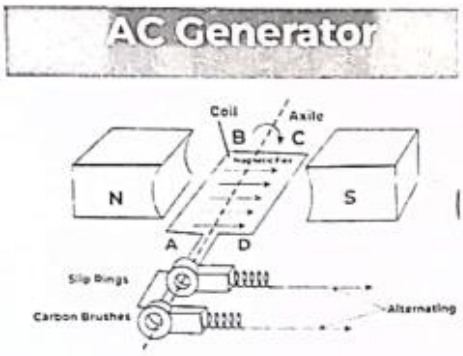


Figure 1: AC Generator

The cinema hall's equipment and the duration at which they will be switched on is given in **table 2.**

Table 2: Cinema Equipment.

Equipment	Power (watts)	Duration (hours / day)
TV	300	14
Refrigerator	3000	5
5 Energy saving bulbs	15 each	12
Loudspeaker	50	8
Automatic electric fan	75	14

Task:

As a physics student;

(a) Regarding the current flow through the sides **ABCD** of the rectangular coil of the AC generator as shown in **Figure 1**. Explain how an **AC** generator works.

(b) Use a circuit diagram to explain to the community leader how the automatic electric fan that depends on temperature installed in the hall works.

(c) If the community leader has a budget for fuel less than Shs 100,000 for five days. Comment whether the leader will be able to run the generator for the five days.

(d) Discuss any dangers associated with electricity and suggest the safety precautions.

Hint:

(i) *For every 0.4 litres of diesel consumed, the generator produces approximately* ***1.8 kWh*** *of electric energy.*

(ii) *1 litre of diesel costs Shs 4950*

Item 5.

In the previous rainy season, there was a powerful lightning that was observed striking severely damaging an area transformer causing a power shutdown. The team found out that lightning strike led to a voltage increase in the transformer's secondary coils well above the standard **240V** that is required by the households. **Figure 2** shows the winding of coils in the secondary and primary coils.

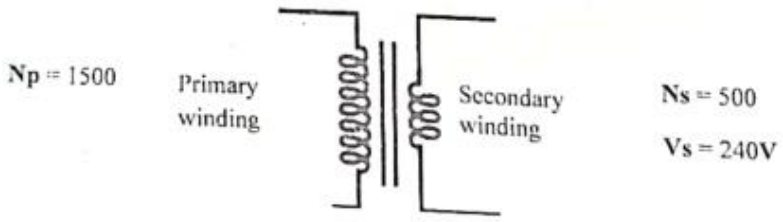


Figure 2: Transformer

This unexpected event led to widespread damage, burning out numerous home appliances and resulting in significant financial losses for the residents. Upon investigating the incident, the team from the local area electricity distribution company discovered a critical electricity anomaly. The homes that suffered the most damage had poorly connected or inadequate earthing systems. Therefore, the team has organised a sensitization program for the citizens and you as a physics student you are invited to be part of the facilitators.

Task:

As a physics student sensitize the area citizens on;

(a) Suggesting ways on how area citizens can safeguard themselves from such dangers of lightning.

(b) Explain the purpose of earthing in their household electrical system?

(c) Several households wish to install automatic electric bulbs that depend on intensity of light. explain how such bulbs work.

(d) A transformer to be replaced is expected to deliver an output of 20 KW with a primary current of 28.7 A. Comment whether such a transformer can be recommended as a good one for use.

(e) Discuss any **two** factors that might affect the efficiency of the transformer and suggest ways to minimize each of them.

Hint:

(i) A good ideal transformer should operate at an efficiency of between 95% - 99%