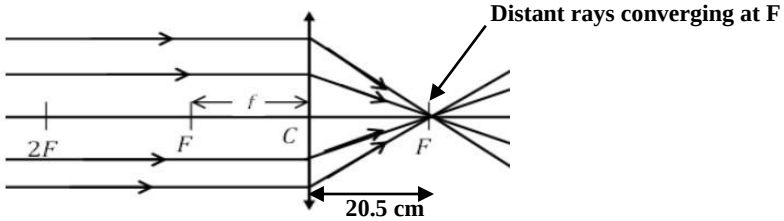
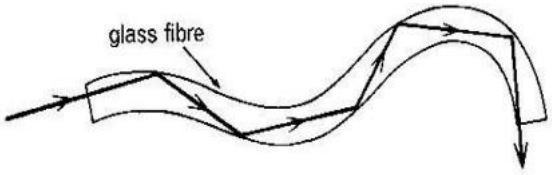
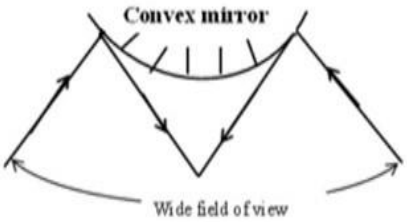
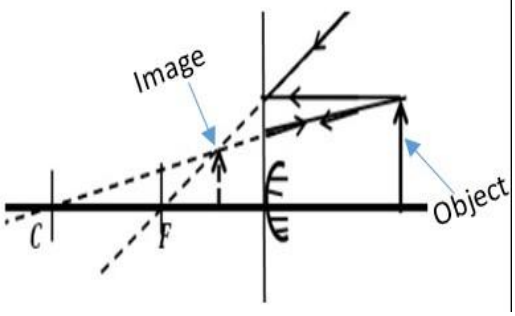
THE GRAND PHYSICS SEMINAR AT VISION FOR AFRICA HIGH SCHOOL NAKIFUMA
ON Saturday 14TH JUNE 2025
UCE - 535/1 PHYSICS PAPER 1 (THEORY)
SEMINAR SOLUTIONS

No.	Task(s)	**Expected response**
1	a) Explain to your friends in the lower classes why the walls of the studios are made the way you observed and what would go wrong if they are left bare and hard.	- The walls were covered with soft, thick woollen materials to reduce the effect of reverberation/reflection because they absorb the sound waves. - If it were bare and hard, the incident sound waves would mix with the reflected wave, producing a prolonged and confused sound.
	b) Explain how and why the colors of the students' uniforms kept on changing as the flash lights changed color.	- The appearance of an object depends on the light falling on it and that reflected or absorbed by the object. - When green light falls on the students' uniform, the blue skirt appears black, the white skirt appears green and the yellow collar appears green - When the red light falls on the students' uniform, the blue skirt appears black, the white shirt appears red and the yellow colour appears red. That's how the colour of the clothes kept changing.
	c) Determine how many images your friend saw while in the studio.	$Number\ of\ images = \frac{360}{\theta} - 1$ $= \frac{360}{60} - 1$ $= 6 - 1$ $Number\ of\ images\ = 5$ Therefore the friend saw five images.
	d) Determine which FM radio station you went to.	$v = \lambda f$ $3 \times 10^8 = 3.3 \times f$ $f = \frac{3 \times 10^8}{3.3}$ $f = 90.9MHz$ Tower FM was broadcasting at 100.2 MHz and KT FM broadcasting at 90.9 MHz, and since the frequency in my calculations was 90.9 MHz, then we went to KT FM.
2	Provide clear explanations to the supervisors' friend on; a) The distance where the lens can be placed from the tissue specimen for the best results.	- In a convex lens, rays from a distant object converge to the focal point (principal focus) after refraction through it. 

		- Therefore, the tissue should be placed at 20.5 cm from lens the so that a beam of light from the opposite side of the lens will be concentrated on it.
	b) How the optical fiber achieves the purpose intended in the project.	When light is incident at one end of the fibre with its angle of incidence greater than the critical angle, the light is continuously totally internally reflected until it emerges out. The fibre is made the fibre is made such that the inner surface has a slightly higher refractive index than the outer. 
	c) The nature of radiation used by the cashier.	The cashier was using ultra violet radiations to verify the banknotes. This is because ; Genuine notes always have hidden security features invisible under normal light but become visible under UV light. In addition, UV lamps are relatively cheap and verify the notes faster, compared to other advanced technologies like infra-red and magnetic sensors.
3	Help the learners to be able to: (a) describe how the ground and water are shaken in two different ways and the respective waves that occur.	The earth quake shakes the ground <u>parallel to</u> the direction of <u>transmission of energy.</u> This results in a <u>longitudinal wave</u> along the ground. The earth quake also shakes the ground perpendicular <u>to</u> the direction of transmission of energy. This results in a <u>transverse wave</u> along the ground. The two waves <u>transmit the earthquake from the epicentre.</u> The vibrations are also transmitted to the water resulting in a <u>transverse wave in water</u> which is <u>the tsunami</u>.
	(b) explain why destruction may occur even in far off places from the epicentre.	<u>A wave is a means of transfer of energy</u> therefore energy from the epicentre is transmitted <u>to far places</u> where destruction may occur.
	(c) explain why people in far off places can get the warning by broadcast before disaster reaches them.	<u>Radio waves</u> that are used in broadcasting travel at the <u>speed of light</u> which <u>is much more than the speed of mechanical waves</u> of an earthquake or a tsunami. Therefore people in far places can get the <u>broadcast before the mechanical waves reach</u> them.
4	(a) explain; i. why the people at the back row complained that the sound is distorted and how that effect can be reduced.	i. The people at the back row heard *<u>sound that is mixed with echoes</u>*, hence the distortion. $\text{Velocity of sound} = \frac{2 \text{ x distance}}{\text{Time}}$ $330 = \frac{2 \times 105}{t} \qquad t = \frac{210}{330} \qquad \boldsymbol{t = 0.64s}$ The second sound is an echo. This means that the people at the back hear echoes 0.64 s later and this causes the distortion of sound. **How to reduce the distortion of sound**

		Lining the cinema with sound absorbing materials such as soft boards, acoustic panels/materials, floor rugs/carpets, and sound blankets, Covering the floor with soft carpet, and putting chairs in the hall with soft cushions. These absorb sound waves incident on them and reduce reflection of sound.
	ii. why there were differences in the effect of sound on the residents during day and during night, and how the effect can be reduced.	The sound travelling further at night because of ***refraction of sound*.** During day, the ground is hot. This makes *layers of air close to the ground hotter than those above it* which makes them *less dense*. Sound waves are therefore *refracted away from the ground*, hence heard at shorter distance. At night, the ground is cool. The *layers of air close to the ground are cooler than those above it* which makes them *denser*. *Sound waves are hence refracted towards the ground*, hence *travelling further*. So this makes the sound at night to have a greater effect on the people at a further distance than the same sound during day time. **How to reduce the noise pollution especially at night** *Sound proofing the entire hall/ using sound absorbing materials inside the hal such as acoustic panels***,** *Keeping the volume of sound low, avoid playing music/showing videos late in the night and set up sound barriers such as noise-reducing walls or fences.*
	iii. why the entrance must have white lights and not coloured lights.	- White light is a combination of all colours. - The cloth of any person entering through the gate will absorb all colour in white light and reflect only the one in the cloth - This enables security personnel to clearly identify the colours of clothes of the people entering the hall.
	iv. the kind of curved mirrors are used by the guards to check below the customers' cars and how such mirrors are able to perform their role.	- The guards use *convex mirrors attached to a rod* at the bottom to check under cars - Convex mirrors are used/ are able to perform that role because they have a wide field of view, form diminished images that are upright/erect which makes it easy for the guards to interpret as they check under the cars.  
	(b) determine if the sound from the speaker damages the ears of the viewers and what should be done to solve this problem.	$v = \lambda f$ $330 = f$ x 0.005 $f = \frac{330}{0.005}$ $f = 66{,}000\ Hz$ It is true that sound from the speaker damages the viewers' ears.

Human ears are able to hear sound in the range of 20 Hz – 20,000 Hz. However, the speaker's sound is of frequency 66,000Hz, which is higher than the audible range.

Solution to the problem: Replace the speaker with one that produces waves of higher wave length such as 0.0165 m so that it produces audible waves of frequency in the range 20 Hz – 20,000 Hz.

5 As a student of physics,

a) Help the patient to determine the date for his next visit.

Time (days)	Mass remaining (mg)
0	12
5	6
10	3
15	1.5
20	0.75

$Total\ number\ of\ days = 20,$

So, the next visit will be on (2 + 20) = 22nd June 2025.

Alternatively,

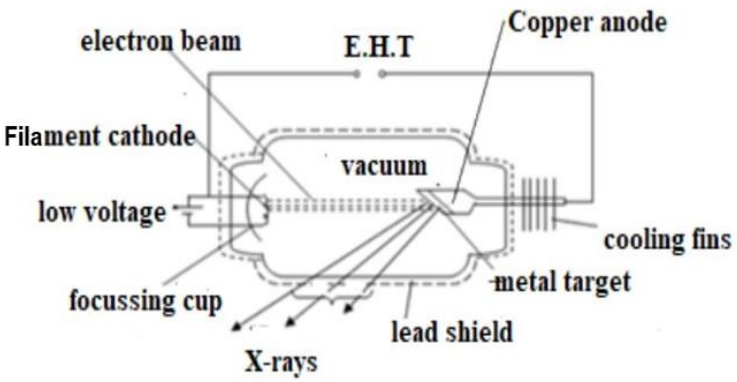
$$12 \xrightarrow{5\ years} 6 \xrightarrow{5\ years} 3 \xrightarrow{5\ years} 1.5 \xrightarrow{5\ years} 0.75$$

$Total\ number\ of\ days = 5 + 5 + 5 + 5 = 20$ days

So, the next visit will be on (2 + 20) = 22nd June 2025.

b) Explain to the patient the effect of the faulty part of the machine on its operation.

- The scanning rays are x-rays. Soft x-rays which are the recommended ones for scanning the human body.
- The x-rays are produced in an x-ray tube.



A low voltage supply heats the cathode filament; the filament then emits electrons by thermionic emission, the emitted electrons are the emitted electrons produce x-rays when they strike a metal target.

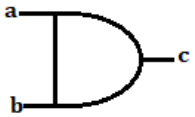
- When the low voltage supply is faulty, the electrons cannot be emitted and x-rays are therefore not produced, thus scanning cannot take place.

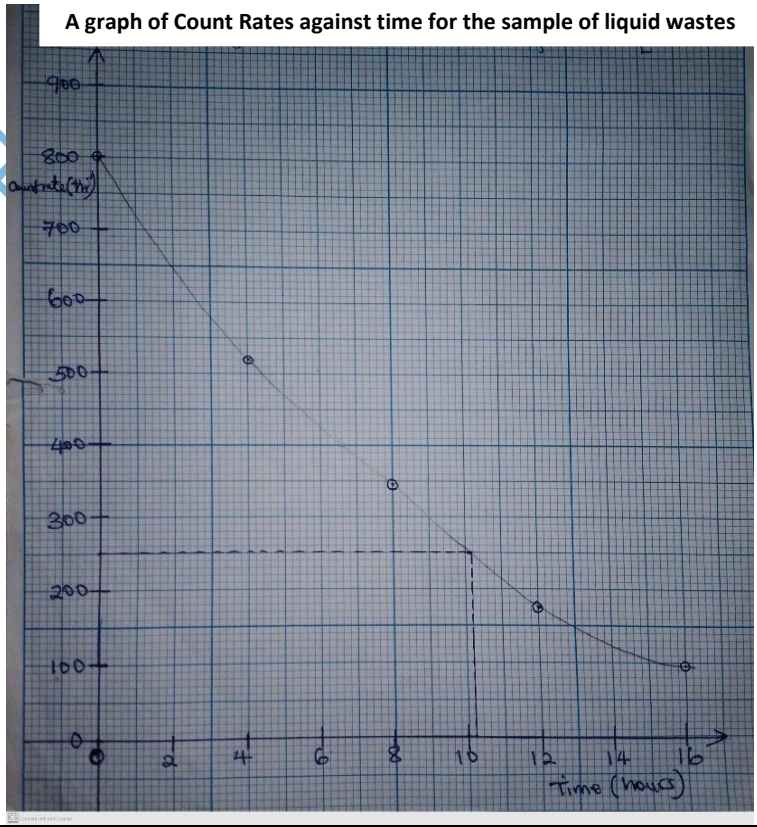
The dosage is radioactive; therefore, it keeps emitting radiations. These radiations can:

- Cause deep lying skin burns
- Cause genetic mutation
- Damage eye sight
- Cause sterility, E.T.C.

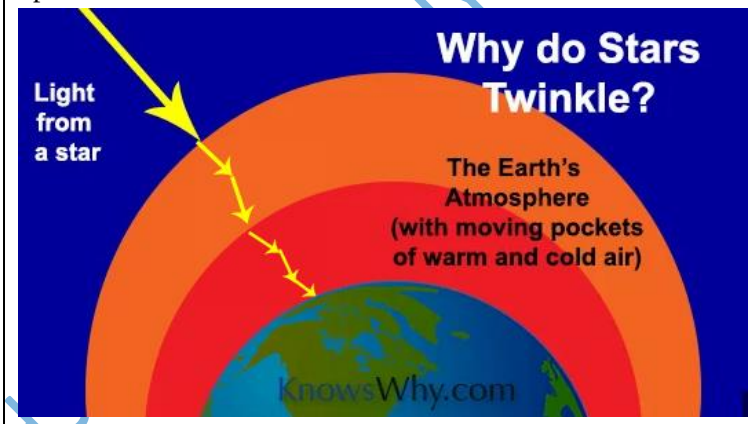
<table>
<tr><td></td><td></td><td></td></tr>
<tr><td>6</td><td>As a learner who has studied physics, help the home owner to:
(a) Make necessary calculations to find out whether the charger circuit will be able to efficiently charge the battery.</td><td>In the charger circuit R and S make up a potential divider.

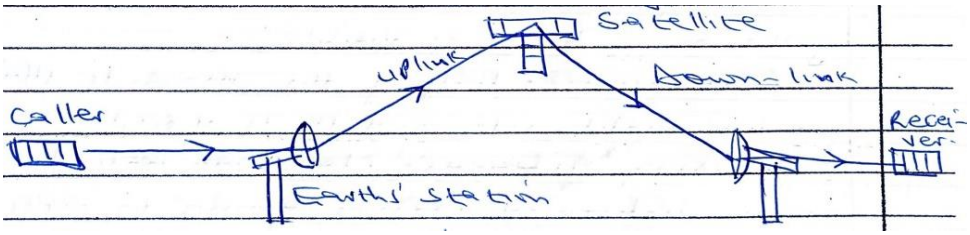
P.d, V' across R,
$V' = \frac{RV}{R+S}$ $\rightarrow V' = \frac{200\ x\ 52}{200+600}$ $\rightarrow$ V' = 13 V

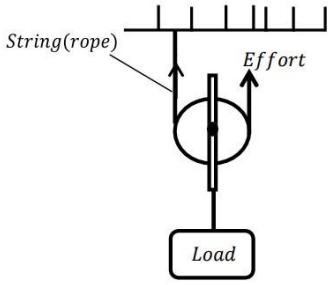
This p.d is less than the required 14 V, but greater than the 12 V. Therefore the circuit will charge the battery but not to the recommended extent.</td></tr>
<tr><td></td><td>(b) Identify the type of gate, X; giving reasons for your response.</td><td>Gate X is a NOT gate.</td></tr>
<tr><td></td><td>(c) Identify the gate to be connected at a, b and c so that the night bulb is automatically switched on only when night falls.</td><td>The gate at a, b and c is an AND gate.</td></tr>
<tr><td></td><td>(ii) Draw the circuit symbol for the gate chosen in (c) (i).</td><td>  </td></tr>
<tr><td></td><td>(iii) Draw the truth table for the gate chosen in (c)(i).</td><td>The truth table:<table><tr><td>a</td><td>b</td><td>c</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table></td></tr>
<tr><td>7</td><td>As a student of physics, help the local authorities;
(a) Identify the type of radiation that was emitted by the isotope in water for the leakage detection.</td><td>The type of radiation is gamma rays because it penetrates the most making it easy to be detected from leaked water.</td></tr>
<tr><td></td><td>(b) Understand why the technician introduced that isotope as opposed to the one used by National water authorities.</td><td>An isotope of half-life 6 hours;
- It decays faster allowing water to be safe for drinking after a short time.
- It also produces more radiations in a short time, increasing the intensity of radiations in a given time and thus easy detection.</td></tr>
<tr><td></td><td>(c) Sensitize the members of the communities about the risks associated with the kind of material introduced into the water</td><td>The isotope emits radiations which when exposed to can be harmful since they;
- Cause genetic mutation, cause deep lying skin burns, cause cancer and destroy eye sight.
The risks can be minimized by;
- Wearing protective gears while dealing with the isotope, storing the isotope in thick lad containers and minimizing exposure time as much as possible.</td></tr>
<tr><td></td><td>(d) Understand when to tell the community members that the water is safe again for use.</td><td><table><tr><td>Time taken (hours)</td><td>Mass remaining (g)</td><td>Percentage mass remaining (%)</td></tr><tr><td>0</td><td>8</td><td>100</td></tr><tr><td>6</td><td>4</td><td>50</td></tr><tr><td>12</td><td>2</td><td>25</td></tr><tr><td>18</td><td>1</td><td>12.5</td></tr><tr><td>24</td><td>0.5</td><td>6.25</td></tr></table></td></tr>
</table>

		It will take 24 hours for the water to be safe again for use.
8	(a) help the community members to understand: (i) the difference between the two ways of producing the energy.	***Nuclear Fission*** involves <u>splitting the nucleus</u> of a big <u>unstable nuclide</u> resulting in formation of <u>two more stable nuclides</u> and <u>production of particles</u> and <u>energy</u>. ***Nuclear Fusion*** involves <u>combining of two nuclei</u> of unstable nuclides resulting in formation <u>of a bigger more stable nuclide</u> and production of particles and energy.
	(ii) how energy results from the reactions.	The energy is a result of a <u>difference in mass</u> of the reactants and the products. This difference in <u>mass is converted into energy</u>.
	(b) help the community members to know: (i) the components of the nuclide mentioned.	$^{236}_{92}U$ has a total of <u>236 particles in the nucleus (nucleons)</u>. There are <u>92 protons</u>, <u>92 electrons</u> and <u>144 neutrons</u>.
	(ii) know why this nuclide is suitable for the reactor.	The nuclide is suitable for the reactor because; It has a big <u>unstable nucleus</u> and <u>easily splits into two nuclei</u> plus particles <u>and energy</u>.
	(d) help the community members to: (i) understand why precautions must be taken.	<u>Emissions from the reactor</u> may contain <u>alpha</u>, <u>beta</u> and <u>gamma</u> rays that can cause, <u>cancer</u>, <u>deep seated wounds</u>, <u>genetic mutations</u> and <u>death</u> in people when they get exposed to the radiations.
	(ii) know precautions that must be taken.	<u>Enclose the reactor</u> in <u>thick concrete</u> walls; use <u>protective clothing</u>; <u>avoid prolonged exposure</u>; install <u>radiation detectors.</u>
9	As a student of Physics; a) help the L.C 1 chairman to determine; (i) if the sample is radioactive or not.	In order to determine if the sample is radioactive or not, a graph of count rate against time is plotted:  **Scoring points to note:** - Correct Title - Well labelled axes both vertical and horizontal. - Convenient & suitable scale on both axes. - Plotting the points correctly. - Drawing a curve using free hand, passing through the most of the plotted points. - Appropriate or Correct conclusion.

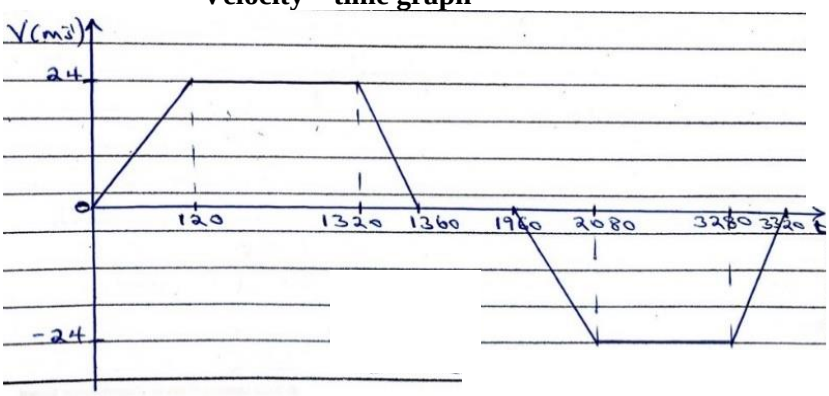
		Conclusion: Since the graph of count rate against time that I have plotted produces a curve then this confirms that the liquid waste is radioactive.
	i) after what time it will be safe to dispose the liquid waste, if it is radioactive.	After drawing a horizontal line from 250 to meet the curve, the corresponding time corresponding to count rate is 10.4 hours. So it will be safe to dispose the radioactive liquid waste 10.4 hours.
	b) educate the L.C 1 chairman about; i) what was meant by the statement "The background radiation in the area is 250 counts per hour"	Background radiation are radiations that continue in existence in the absence of radioactive sources. It is the low-level ionization radiation that is present in the environment from natural sources. - The statement means that a radiation detector is measuring an average of 250 counts (radiation events) per hour in that area.
	(ii) the sources of the background radiations in their area.	***Natural Sources:*** - Cosmic rays i.e. high-energy particles from outer space. - Terrestrial radiation i.e. radiation from naturally occurring radioactive materials in the earth (in rocks or soil) such as Radon gas, Uranium, Thorium, Potassium-40. - Atmospheric radiation i.e. radiation from radon and other radioactive gases in the atmosphere. ***Artificial Sources:*** - Medical Radiation i.e. residual radiation from medical procedures. - Nuclear fallout i.e. radiation from past nuclear accidents or testing. - Industrial radiation e.g Wastes from factories.
	(iii) why it is dangerous for the community members to be exposed to radioactive materials.	**Dangers:** - They cause skin disorders (redness of the skin), gene mutation, cancer, sterility/infertility, nausea and vomiting, radiation burns, hair loss, death, etc.
	(iv) how people dealing with such materials should handle them.	**Precautions:** - Radioactive materials should be held with tongs. - Radioactive materials should be kept in thick lead cases. - Wearing protective clothing like masks, gloves, lab coats, lead jackets, etc. - Labelling containers holding radioactive substances with the radiation symbols or words like Caution or Danger. - People dealing with radioactive materials should not eat, drink in a radioactive lab. - People should not work with radioactive materials if they have an open wounds.
10	Using your knowledge of physics; a) help the man to understand; i) what causes the differences in the occurrences that Uganda is experiencing in relation to other areas.	- The changes in seasons of various regions on earth is as a result of rotation of the earth about the sun where different areas on earth receive more solar energy than others. - The earth takes a full year to take a full orbit around the sun, but it does so in an the elliptical plane which is inclined about the equator at 23.3°. This inclination causes the seasons on earth. - Due to the tilting of the earth, different parts of the globe are oriented towards the sun at different times of the year. - We experience four seasons on earth, i.e. winter, summer, autumn and spring. - Uganda is located in the equatorial region, and so experiences only two seasons (dry and wet) which represent summer and winter. - In the equatorial region, the conditions are almost uniform with no extreme heat or coldness.

		- When the northern hemisphere faces the sun, it experiences summer while the southern hemisphere experiences winter.
	(ii) the usefulness of the artificial objects that were launched in space.	- Research: Collecting data about the earth - Testing new technologies in space such as observing new propulsion systems in space. - Communication between different locations on earth. - Navigation; used in location data and timing of signals for GPS. - Weather Forecasting. - Studying the universe, such as formation and evolution of stars.
	(b) Write an explanation to the man to get more information about; (i) why the sun appears brighter when viewed from Venus than from the earth.	The sun appears brighter when viewed from Venus than from the earth because Venus is closer to the sun than the earth. The apparent brightness of a star varies with distance from it.
	(ii) why the stars are seen to have a certain observable appearance as indicated by the presenter.	Stars appear to twinkle when observed on earth. This appearance is due to continuous refraction of light from the stars as it moves through different regions of the atmosphere, each with different temperature and optical densities. 
	(iii) the effect of mass on the stars' life cycles.	A star's life cycle is ***determined by its mass***, the larger its mass, the shorter its life cycle. **Further explanation:** Star's mass is determined by the amount of matter that is available in its ***nebula***. (Nebula is the giant cloud of gas and the dust from which a star was born). - If a star begins its life with a great amount of mass, it burns hot and fast to maintain equilibrium, so its fuel runs out quickly and dies young with a super massive explosion. - Therefore, more massive stars have shorter lifespans, while less massive stars have longer lifespans. Low-mass stars (like our Sun) have longer lifetimes because they consume their nuclear fuel at a slower rate. -An average sized star lives longer (about 10 billion years) and dies a quiet peaceful death.
	(c)The man used his phone to download images of stars and realized that some were white,	- Stars appear with different colors due to variations in their temperature. - The color of a star is directly related to its surface temperature, with hotter stars emitting more blue light and cooler stars emitting more red light.

	others red, blue or yellow**.** With scientific reasons, help him arrange the stars in order, starting with the coolest up to the hottest**.**	**Blue Stars:** These are the hottest stars ($\Theta \geq 10{,}000℃$) **White Stars:** Slightly cooler than blue stars ($7{,}500℃ \leq \Theta \leq 10{,}000℃$) **Yellow Stars:** Stars like our Sun ($5{,}500℃ \leq \Theta \leq 7{,}500℃$) **Red Stars:** These are the coolest stars, ($\Theta \leq 4{,}000℃$) Coolest: RED Cool: YELLOW Hot: WHITE Hottest: BLUE
11	Help the engineer to understand; a) the technology to use to navigate to the coastline.	- The technology used is a global positioning system (GPS) installed in every smart phone, car and search device. - The GPS is made up of a system of satellites that orbit the earth and continually broadcast their orbital positions and exact time on radio waves. - The information about the name of the place is sought by the search device. - The GPS receivers pick up signals from the satellites: they calculate the distance of the place from each satellite and determine the exact position of the place using a system of three satellites. Then the engineer can locate the place.
	b) the main cause of the storms which pause threats to the city coast line and ships.	The storms are majorly as a result of high tides. High tides are caused by the moon's and sun's gravitational pull. The moon's gravitational pull is stronger than that of the sun. The moon's pull causes the water nearer to the moon to rise/bulge higher than the side furthest from the moon. The bulges are high tides causing the storm in the ocean.
12	Help the elderly man understand; a) How connectivity is achieved.	Connectivity through calls is achieved using communication satellites. When a phone number is dialed, a signal is sent to the telecommunications network which starts the call. The voice message is converted to digital signal. The signal is transmitted to the earth's station (mast) which uplinks the signal to a communication satellite in a geostationary orbit. The satellite receives the signal, filters and amplifies it using a transponder: the signal is then sent back to the earth's receiving station in the recipient's area and finally to the receiver's phone.  The receiver's phone converts the signal to sound and the receiver hears the message
	b) Why the difference of 6 pm and 1 pm at the same time.	The earth's rotation about its axis causes different parts of the planet to experience different times. The different times were as a result of the earth's longitudinal divisions which are 15^0 apart. The planet earth (world) is divided into 24 equal time zones by longitudes. One zone exceeds the other by one hour. Therefore, the elderly man's place and that at Aljazeera T.V were longitudinally placed at different time zones, 5 hours apart thus the difference in time.

	c) Why there are other growing phases that follow after what was just seen.	There are various phases which include; The new moon; the moon is between the earth and the sun. the side facing the earth is not illuminated making it invisible. Waxing crescent; a small crescent shaped portion of the moon becomes very visible First quarter; half of the moon is illuminated on the right side and its visible as a half circle as the lightened portion grows towards a full moon. Full moon; the entire face of the moon is illuminated as the earth is between the moon and the sun.
13	Help the learners to understand; a) the correct arrangement and motion of the heavenly bodies mentioned.	The sun, earth and moon belong to the solar system where the earth moves around the sun once in a year and the moon moves around the earth once in 28 days.
	b) how energy is produced from the central body in the system.	Energy from the sun is a result of a nuclear fusion reaction of nuclei of hydrogen resulting in formation of helium and energy.
	c) the correct cause of appearance of the moon observed by the learners.	What we observe on the moon is that part of the moon reflecting light from the sun to us. Depending on our position of observation relative to the sun, this part can be a crescent of varying size or a full moon. This is waxing and waning of the moon. In this case there is no shadow of the earth on the moon.
	d) what should be taking place if the learners' explanation about appearance of the moon were correct?	If the learner's explanation were correct then this would be an eclipse of the moon (lunar eclipse). But this occurs only once in a long time when the earth moon and the sun lie in a straight line. Eclipse does not occur every month.
14	As a learner of physics, a) State and describe the simple machine used to remove the gentleman for the pit latrine.	Tthe machine is a single movable pulley.  The system consists of a single wheel with a grooved rim. A string is passed around the wheel with one end tied on a fixed support. The man is placed/gets held at the load pan, an effort is applied on the other end of the string pulling it upwards. This makes the pulley to move upwards carrying the load (man). This allows the man to be raised upwards and removed from the pit.
	b) Determine whether the doctor was able to keep time for his next appointment?	During acceleration, $v = u + at$ $v = 0 + 0.2 \times 120$ $v = 24\ ms^{-1}$ During deceleration, $v = u + at$ $0 = 24 \pm 0.6 \times t$ $t = 40\ s$

Velocity – time graph



$$Total\ time\ spent\ = \frac{3320}{60} minutes$$
$$= 55.33\ minutes$$

Since the total time spent; 55.33 minutes is less than 1 hour the doctor was able to keep time for his next appointments.

c) Determine how much was refunded to the doctor for his transport.

$Total\ Distance\ =$ Total Area under the graph

$$= \frac{1}{2} h(a+b) \times 2$$

$$= \frac{1}{2} \times 24 \times (1200 + 1360) \times 2$$
$$= 138{,}240\ m$$

$Total\ distance = 138.24\ km$

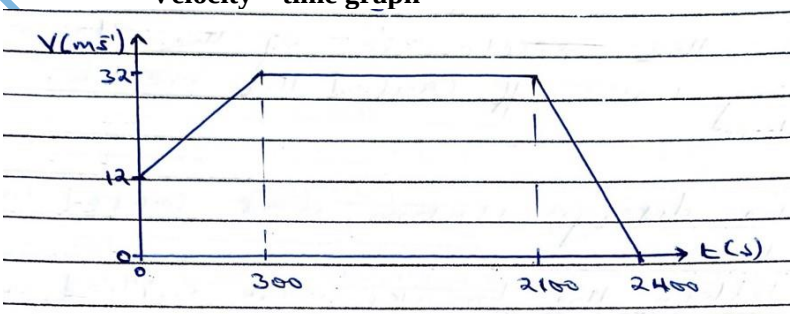
The amount required to fund the doctor $= 138.24 \times 500$
$= shs.\ 69{,}120$

Therefore, the doctor was refunded shs. 69,120 for his transport.

15 As a physics learner, help the aero-plane company to:

a) determine the compensation fee for each passenger.

Velocity – time graph



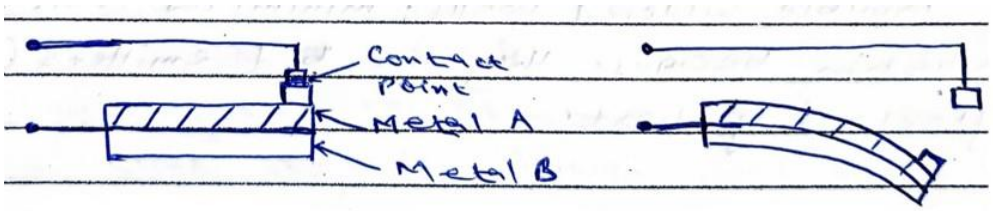
$Total\ distance\ = total\ area\ under\ the\ graph$

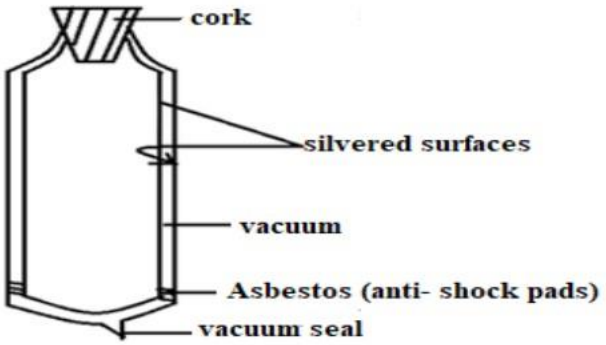
$$= \frac{1}{2} \times 300 \times (12 + 32) + 1800 \times 32 + \frac{1}{2} \times 300 \times 32$$
$$= 6600 + 57600 + 4800$$
$$= 69000\ m$$

$So;\ Total\ distance\ = 69\ km$

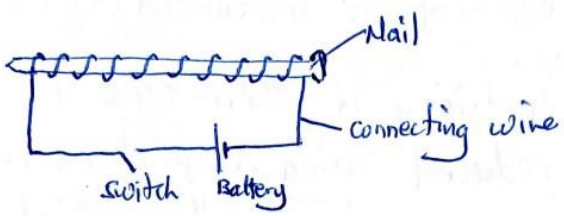
$The\ compensation\ fee = 69 \times 1000$
$= 69000\ /=$

The company will compensate each passenger with shs. 69000/=

	b) ascertain whether the acceleration after take-off caused the mechanical failure.	During acceleration of the plane, $a = \frac{v-u}{t}$ $$a = \frac{32-12}{300}$$ $$a = 0.067\ ms^{-2}$$ Since the acceleration, $a = 0.067\ ms^{-2}$ with which the plane was pulled is greater than the maximum acceleration of $0.05\ ms^{-2}$ then the acceleration caused the mechanical failure.
	c) explain to some passengers what caused their disorganization during the sudden breaking.	The disorganization was caused due to inertia. When the brakes were applied, only the plane was stopped/acted on. The passengers continued moving in a straight line hence jerking forward before coming to a stop.
16	a) Advise the mother if the temperature of the mixed water is not too high to cause challenges to the grand-parents.	$$Heat\ lost\ by\ hot\ water = heat\ gained\ by\ cold\ water$$ $$m_h c_h \Delta\theta = m_c c_c \Delta\theta$$ $$m = \rho \times V$$ $$m_h = 1000 \times 5 \times 10^{-3} = 5kg$$ $$m_c = 1000 \times 20 \times 10^{-3} = 20kg$$ $$4 \times 4200 \times (100-\theta) = 20 \times 4200 \times (\theta - 10)$$ $$100 - \theta = 4\theta - 40$$ $$\theta = 28^0C$$ Since the temperature of the mixed water to be used for bathing is 28^0C which is below 30^0C, then the water will not burn the visitors.
	b) Explain to the grand-parents about the component in the heater to behave surprisingly.	The component is a thermostat (bi-metallic strip). A bi-metallic strip is a metal strip consisting of two metals of different expansivities placed together as shown below.  When the bi-metallic strip is heated, metal A expands more than metal B thus bending. When the bi-metallic strip bends the contact is opened and the circuit breaks switching off the heater automatically
	c) Suggest and describe the working of an equipment that the mother can use to keep this mixed water warm for the next morning,	The equipment is a vacuum flask. It consists of two silvered walls enclosing a vacuum. It is used for keeping contents at a fairly constant temperature.

	since all the visitors will bathe at the same time.	 The vacuum flask maintains the mixed water at a constant temperature by minimizing heat losses by conduction, convection and radiation. The cork minimizes heat loss by convection and conduction since it is a poor conductor of heat. The vacuum minimizes heat loss by conduction and convection because there is no material medium. Double silvered walls minimize heat losses by radiation since they are bad emitters (reflectors) of heat.
17	As a learner of physics, determine whether the vaccine transported on that specific day was still effective by the time of use.	$Total\ time\ of\ travel = \frac{distance}{speed}$ $= \frac{84}{75} = 1.12\ hours$ $= 1.12 \times 60$ $Total\ time\ of\ travel = 67.2\ minutes$ $Temperature\ of\ the\ vaccine\ by\ arrival\ time = 0.8 \times 67.2$ $= 53.76^0C$ Heat gained by ice = Heat gained by glass + Heat gained by vaccine $m_i c_f = m_g c_g \Delta\theta + m_v c_v \Delta\theta$ $0.5 \times 3.36 \times 10^5 = 3.5 \times 840 \times (53.76 - \theta) + 4 \times 250 \times (53.76 - \theta)$ $168{,}000 = 158{,}054.4 - 2940\theta + 53760 - 1000\theta$ $-2940\theta - 1000\theta = 168{,}000 - 158{,}054.4 - 53760$ $-3940\theta = -43814.4$ $\theta = \frac{-43814.4}{-3940}$ $\theta = 11.1^0C$ The final temperature of the vaccine by the time it was picked was 11.1^0C. This implies that the vaccine will be effective for use since the temperature is between 10^0C and 28^0C
18	a) Describe to the trainees the different layers and their properties that are suitable for each of the mentioned activities to take place.	**Troposphere:** is the layer closest to the earth's surface. Weather happens here. Has life. Temperature reduces with altitude.

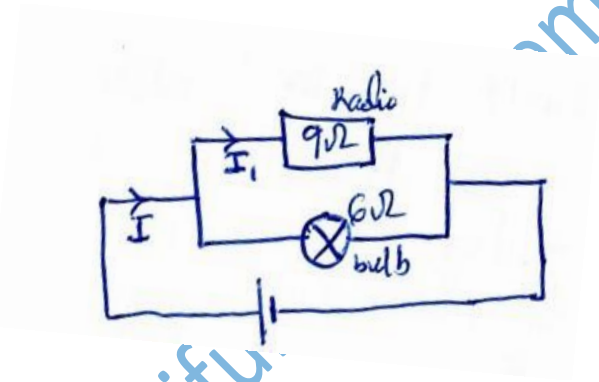
		Stratosphere: Next after troposphere. Temperature increases with altitude. Has less turbulence. Aircraft can fly on lower side. Ozone layer on the upper side protects the earth from dangerous radiation from the sun. **Mesosphere:** Next after stratosphere. Temperature decreases with altitude. Has lowers temperature. Has meteors. Protect earth from space debris as they burn up here. **Thermosphere:** Next to mesosphere. Temperature here rises but is not very high due to low density of matter. Satellites are positioned here. **Exosphere:** mostly hydrogen and helium. Extremely low pressure in transition to vacuum.
	(b) Explain to the trainees why: (i) Nose bleeding may happen to some of them.	Atmospheric pressure reduces as altitude increases due reduction in depth of air and the air becoming thinner. Therefore blood pressure will be higher relative to the atmospheric pressure. This may cause delicate blood vessels in the nose to burst hence causing nose bleeding.
	(ii) It was necessary to carry pressure cookers even when the foods they expected to cook do not usually need a pressure cooker.	Water boils when its saturated vapour pressure equals atmospheric pressure. When atmospheric pressure is reduced boiling takes place at a lower temperature. Therefore water in the food being cooked will be boiling at a low temperature and may take long to cook or the food may fail to cook. A pressure cooker increases boiling point of water so that food cooks more easily.
19	Help Jane to understand: (a) Why the mechanic used a towel soaked in water for holding the cap of the radiator.	The towel and the water are poor conductors of heat so the hot cap will not burn the mechanic's fingers. Water has a high heat capacity therefore it will its temperature will not raise quickly when it absorbs heat.
	(b) features of the radiator that enable it perform its role efficiently.	Made of metal that is a good conductor of heat. Has fins to increase surface area for radiation of heat. Is black to radiate heat quickly.
	(c) how overheating is controlled.	Water from the radiator flows to the engine and absorbs heat. The heated water expands, rises and moves back to the radiator. The radiator emits the heat and cools the water. The water flows back to the engine and the convection current continues.
	(d) why water is a good choice for the role it plays.	Water absorbs a lot of heat to raise its temperature due to the high heat capacity. Water absorbs a lot of heat to change to steam due to high latent heat capacity. Water is cheap and readily available.
20	As a learner of physics, help your friends to; (a) explore the alternative device you can invent and use to navigate through the forest.	The device is an electromagnet. An insulated copper wire is wound around the steel nail to make a solenoid. The ends of the wire are connected to a battery using connecting wires through a switch as shown below



- The switch is closed, current flows through the coil making the nail to get magnetized.
- The nail is removed from the coil and freely suspended using a string.
- The nail swings and comes to rest in facing north-south direction due to the influence of the earth's magnetic field.
- The end of the magnetized nail pointing to the geographic south is the south pole and that pointing to the geographic north is the north pole.

(c) determine the circuit connection that would help both the radio and the bulb to operate normally.

For Parallel Connection



$$R = \frac{R_1 R_2}{R_1 + R_2}$$

$$R = \frac{9 \times 6}{9 + 6}$$

$$R = 3.6\Omega$$

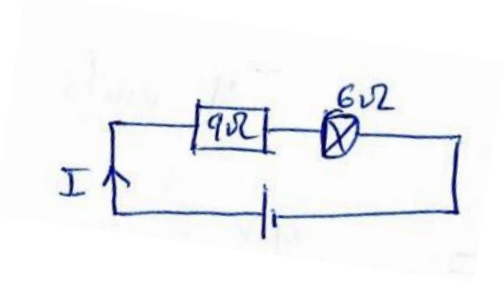
$$I = \frac{V}{R}$$

$$I = \frac{12}{3.6}$$

$$I = 3.33A$$

The Parallel Connection is not suitable because current in the circuit exceeds the fuse rating. The fuse will blow.

For Series Connection



$$R = R_1 + R_2$$

$$R = 9 + 6$$

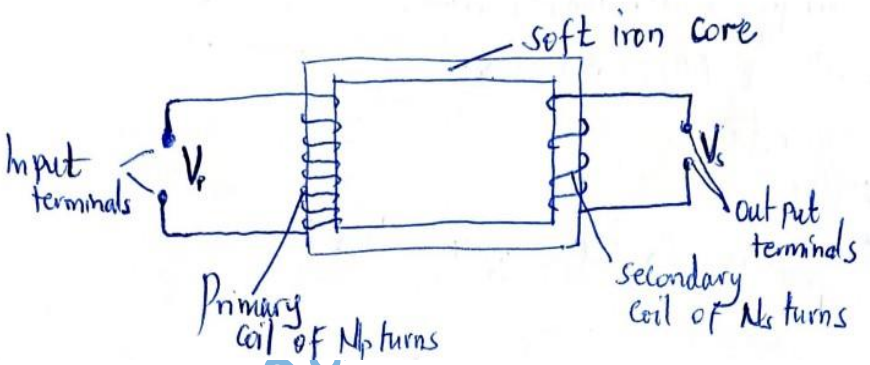
$$R = 15\Omega$$

$$I = \frac{12}{15}$$

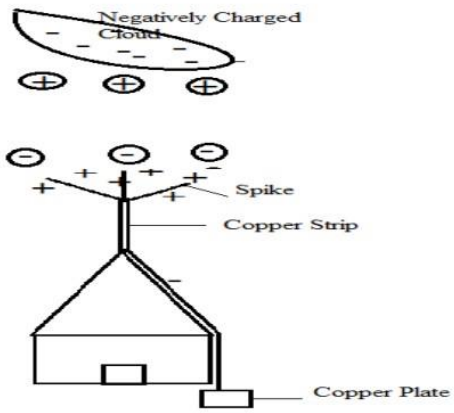
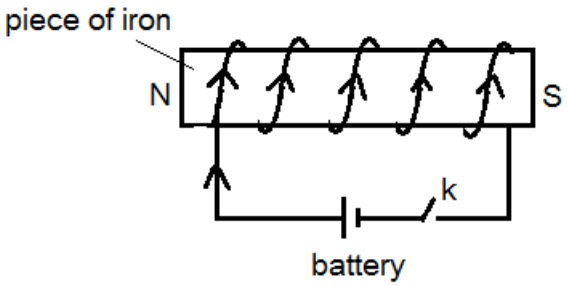
$$I = 0.8A$$

The Series Connection is suitable for the operation of both the radio and the bulb because current in the circuit does not exceeds the fuse rating.

21	As a learner of physics; a) Explain to the mayor the processes involved until the city is lit which makes the process time taking and expensive.	- At the power plant, the spinning turbines are connected to alternating current generator which converts mechanical energy of the turbines into electrical energy. - The voltage of the electricity generated is increased using a step-up transformer to minimize losses during transmission. This voltage is transmitted over long distances using transmission lines. - The transmitted electricity is then sent to sub-stations where the voltage is reduced using a step-down transformer. The low voltage is then distributed to the end users in the city using distribution lines. - These processes make it expensive and time consuming.
	b) Help the home owner to either hold onto his budget or adjust when the city is finally light.	$Cost\ of\ electricity = number\ of\ units\ consumed(kwh) \times unit\ cost$ $daily\ units\ consumed$ $= \left(\frac{1000}{1000} \times 3\right) + \left(\frac{400}{1000} \times \frac{45}{60}\right) + \left(\frac{200}{1000} \times 2\right) + \left(\frac{60}{1000} \times 5\right)$ $= 3 + 0.3 + 0.4 + 0.3$ $= 4\ units$ $Monthly\ units = 4 \times 30$ $Monthly\ units = 120\ units$ $So\ the\ Cost\ of\ electricity = 120 \times 600$ $= 72000\ /=$ The home owner needs to adjust the budget since the total cost is greater than 50,000/= by adding more 22,000/=.
22	Help the owner to; a) Identify the components A, B, C, E and H.	A - Charge controller/Charge regulator B - Battery/ Accumulator C - Inverter E - a.c bulb H – d.c junction box
	b) Understand the role of A and C in Solar installation.	***The role of A*** - To control the amount of electrical energy flowing into the battery, ensuring that the battery charges efficiently and safely. - It prevents the battery from over charging which may damage and reduce the battery's lifespan. ***Role of C*** - The inverter converts direct current generated by the solar panels into alternating current.
	c) Understand type of current used by bulb D and E.	D uses direct current since it is connected directly to A E uses alternating current since its current comes from the inverter. Alternating current is that which changes periodically with time in both magnitude and direction.

	d) Understand how the installation can be able to provide power at night in the absence of sunlight.	The system can provide power at night due to the battery/storage cell. During the day the solar panels charge the battery storing excess energy which can be used at night.
	e) Understand the care and management of component B.	- Regularly clean the battery terminals and cables to prevent corrosion - Regularly check the water levels to avoid exposure of the electrodes. - Store batteries in cool dry places free from extreme temperatures. - Keep monitoring the battery's state of charge to avoid over discharging.
23	As a physics learner, guide the business man on the: a) kind of the transformer to buy and its operation.	The business man should buy a **step-down transformer**.  When an alternating voltage, V_P is applied to the primary coil, an alternating current flows in the primary coil. The current creates a changing magnetic flux in the primary coil which links up with the secondary coil. An e.m.f , V_S is induced in a the secondary whose magnitude is lower than that of V_P since$N_P > N_S$
	b) kind of fuse to use in his metre box.	$I_P = 5A$ $Efficiency, \eta = 65\%,$ $N_P = 13750$ $V_P = 2200V,\ V_S = 240V$ $From\ \eta = \frac{I_S V_S}{I_P V_P} \times 100$ $\eta = \frac{I_S \times 240}{5 \times 2200} \times 100$ $I_S = 29.79A$ The fuse to use in the metre box should be rated 30 A.
	c) specification of the transformer needed.	From the transformer equation, $\frac{V_P}{V_S} = \frac{N_P}{N_S}$ $\frac{2200}{240} = \frac{13750}{N_S}$

		$N_S = 1500\ turns$ The transformer should have 13750 turns in the primary coil and 1500 turns in the secondary coil.
24	(a) Explain to the family members the meaning of the number of units bought.	20 units means that an appliance of power 1000W will use all the electric energy bought in 20 hours
	(b) Use necessary calculations to give advice to the members on whether they were cheated.	Energy used by filament bulbs in one week, $Energy\ Units = \frac{Power \text{ x Number of appliances}}{1000}$ $Energy\ Units = \frac{100 \text{ x } 6 \text{ x } 7}{1000} = 21\ Units$ Energy used by heater in one week, $Energy = 2000 \text{ x } 1 \text{ x } 2 \text{ x } 0.25 \text{ x } 7$ $Energy\ Units = \frac{2000 \text{ x } 1 \text{ x } 2 \text{ x } 0.25 \text{ x } 7}{1000} = 7\ Units$ Total units in a week, $E = 21 + 7 = 28\ Units$ Therefore the 20 units bought cannot last a week. They were not being cheated.
	(c) Explain to the members of the home why the rooms get hot when their lights are switched on.	Rooms get hot because filament bulbs produce a lot of heat in order to produce the light. The heat produced heats up the rooms.
	(d) Explain to the family members ways of reducing the electricity consumption even when they are still using it for same purposes.	- Use energy saver (LED) bulbs instead of filament bulbs. These produce the same amount of light with less electric power used because they produce less heat. - Heat the water in an electric kettle (percolator) because this gives the heat directly to the water unlike the coil which radiates more heat outside.
25	a) Explain to the lady: i) the process that led to the strong bright flash and heavy sound that was experienced.	Lightning was experienced. **The process of lighting:** - During a storm, clouds rub against each other and get charged by friction. - Lighter positively charged particles move to the top of the cloud while the heavier negatively charged particles move to the bottom of the cloud. - The negatively charged particles at the bottom of the cloud move downwards and meet the positively charged particles rising from the earth leading to lightning.
	ii) the type of metal rod or system that made the neighbour's home safe from this disaster, and how it works.	The metal rod was a lightning conductor/Arrestor.

		THE LIGHTNING CONDUCTOR  - When a negatively charged cloud passes over the spikes, it induces a positive charge on the spike and repels negative charges to the earth - Ionization of air around the spikes occurs forming positive and negative ions. - Positive ions are attracted to the cloud and partly neutralize the negative charges there. - Negative ions are attracted to the spikes and neutralize the positive charges on the spike. - The excess negative charges are driven to the earth through the copper strip which reduces the possibility of lightning.
	ii) other safety measures that should be taken by anyone inside or outside a house in order to avoid effects of that electrostatic discharge.	Other than installing lightning conductors on buildings, the following should be done; When it is raining: – Do not touch un insulated lightning conductor. – Avoid open places like playgrounds. – Keep indoors. – Do not take shelter under a tree. – Do not touch water since it is a good conductor of electricity and lightning can travel through it. – Do not touch or use metal objects such as fences or umbrella since metals are conductors of electricity and can attract lightning. – Do not touch metallic windows or doors. – Switch off electrical appliances so that they don't get damaged by lightning.
	b) You have an iron nail of resistance 0.5Ω and a battery of 4 cells, each of e.m.f 1.5V. i.) Explain how you can construct an electromagnet to assist the lady continue preparing her meal and explain how an electromagnet operates.	An electromagnet is a temporary magnet made by strongly magnetizing a soft iron bar placed in a solenoid carrying current. 

		A parallel connection of cells will be used since there is less drain of the cells as they share the total current hence having a long span. When cells of the same $e.m.f$ are connected in parallel, Total $e.m.f$, $\boldsymbol{E} = \boldsymbol{E_1} = \boldsymbol{E_2} = \boldsymbol{E_3} = \boldsymbol{E_4}$ .... $So,\ E.m.f = 1.5\ V$ U*sing Ohm's Law,* $V = IR$, then: $I = \frac{V}{R}$ $I = \frac{1.5}{0.5}$; $I = 3.0\ A$ - A current-carrying insulated copper wire is wound several times around the iron nail to make a solenoid. A current of 3.*0 A* flows through the coils by switching it on for a short time and then switching it off. - As the electricity moves, it creates a magnetic field around the nail which results is formation of a temporary magnet. When the current is switched off, the temporary magnetism is lost. The *poles of the electromagnet formed can be determined* by: - *Looking at <u>the direction of flow of current</u> from one pole of the electromagnet*; i.e. if current is moving anti-clockwise, then that end is a North Pole, and if it is moving clockwise, then that end is a South Pole. - *Using <u>the Right hand grip rule</u>* to hold the coil of the electromagnet in our right hand with fingers pointing in the direction of the current, then our thumb points towards the North Pole of the magnet, and the other pole is then the South Pole.
		How: - She needs to pass the electro-magnet close to the rice mixed with the tiny metals. - The metals are magnetic materials and will all be sorted out of the rice by attraction by the electromagnet. - The rice will remain on the tray not attracted to the electro-magnet since it is a non-magnetic material. - The rice will now be safe for cooking. The lady can now continue preparing her evening rice meal.
	ii.) Explain what would happen if a battery of 2 cells of the same e.m.f was used instead of one of 4 cells.	The resultant e.m.f will be equal to the e.m.f of any one of the cells. If the cells were of different e.m.f, then the resultant e.m.f will be equal to the e.m.f of the cell which is having a greater value of e.m.f. - The two cells will not exhaust or get used up easily.
	iii.) Identify other factors that could contribute to an increase in the number of metals being attracted.	• Length of wire/coil/solenoid; a longer wire gives more turns in the solenoid used hence a stronger magnet. • Quantity of current used; Using high current in the coils/solenoid makes a stronger magnet. • Weight of the nail; using a metallic nail of less weight gives a stronger electromagnet. • Size of the nail; increasing the size of nail produces a stronger electromagnet.

⇨ ***The department appreciates all teachers/facilitators & all learners/ participants in this seminar. May God see you to great grades, come UNEB 2025.***

⇨ ***The department reserves the rights of publication of this guide. Any mistakes/errors in the items and solutions are highly regretted. This is the NCBC and this production reflects creative work that is in progress and is undergoing continuous improvements.***

THE END