O-LEVEL PHYSICS SEMINAR SLATED FOR 23RD JUNE 2024 AT ST JOSEPH OF NAZARETH HIGH SCHOOL KAVULE-KATENDE
SEMINAR EXPECTED RESPONSES

Light and waves

Item 1

(a) Distance = 15cm
Boy A = 3s
Boy B = 4s

For boy A
Distance = $speed \times time$
$= 330 \times 3$
$Distance = 990m$

For boy B
Distance = $speed \times time$
$= 330 \times 4$
$Distance = 1320m$

The two boys heard the sound at different time intervals because they were at different distances from the guitar being played by the man on the floating stage.

(b) The colour of clothes changed due to the effect of the coloured lights falling on them from the disco lights flashing red, blue and green.
Due to light colour mixing:
- In red, clothes appeared red with black spots.
- In blue, clothes appeared black.
- In green light, the clothes appeared green with black spots.

(c) The laser sources of light produce monochromatic light that is strong enough to travel longer distances without fading.

(d) For sound waves travelling in air
$v = \lambda f$
$330 = \lambda \times 440$
$\lambda = \frac{330}{440}$
$\lambda = 0.75m$

For light waves travelling in air
$v = \lambda f$
$3.0 \times 10^8 = \lambda \times (4.744 \times 10^{14})$

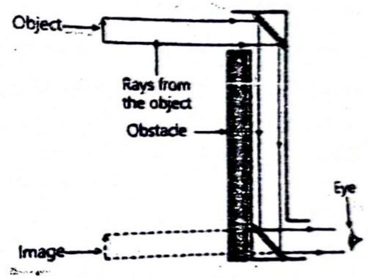
$\lambda = \frac{3.0 \times 10^8}{4.744 \times 10^{14}}$
$\lambda = 632.4 \times 10^{-9} m$

The wave length of laser light waves travelling in air is smaller than the wave length of sound waves travelling in air. Implying that the smaller the wave length the faster the wave in relation to speed and the lower the wave length the slower the wave in relation to speed.

Item 2

(a) When the stone is dropped in water, a high pitched slapping sound is heard when the stone makes contact with the water. This is due to the air between the stone and the water being pushed out as well as the surface ripples that travel radially in all directions in a to and fro motion.

(b) The soldiers should make a periscope using the small sizable plane mirrors and torn paper box.



The two plane mirrors face each other and are fixed at 45^0 angles. Light from a distant object is turned through 90^0 at each reflection producing an upright image. Therefore, instead of sending spies, the soldiers can use this instrument to spy enemy location behind mountains.

(c) The bright colours in the skies was a rainbow.
The atmosphere has many water droplets when it's just about to rain or has just rained. If the sun rises at this moment, rays of light will strike the water droplets in the air. As soon as light enters a droplet, it splits into a band of colours. When the band of colours strikes the other edge of the droplet, it undergoes total internal reflection and moves towards the first edge of the droplet. This band of colours finally come out of the rain droplet and is seen as a rainbow.

(d) From the graph;
Period = 4s

But $frequency = \frac{1}{period}$

$frequency = \frac{1}{4}$

$frequency = 0.25Hz$

Solar System, Stars and Galaxies, Satellites and Communication and Digital Electronics.

Item 3

(a) The occurrence of seasons is due to the combination of two main factors:

1. Earth's Axial Tilt: The Earth rotates on its axis, which is tilted at an angle of approximately 23.5 degrees relative to its orbital plane around the Sun.
2. Earth's Orbital Path: The Earth orbits the Sun in an elliptical path, which means its distance from the Sun varies throughout the year.

As the Earth rotates and orbits the Sun, different parts of the planet receive varying amounts of sunlight, leading to changes in temperature, weather patterns, and the seasons.

A brief overview of each season is as below:

- Spring: As the Earth continues its orbit, the Northern Hemisphere begins to tilt towards the Sun, increasing sunlight and temperatures.
- Summer: The Northern Hemisphere is now maximally tilted towards the Sun, receiving the most direct sunlight and experiencing the longest days.
- Autumn (Fall): The Northern Hemisphere starts to tilt away from the Sun, reducing sunlight and temperatures.
- Winter: The Northern Hemisphere is maximally tilted away from the Sun, receiving the least amount of sunlight and experiencing the shortest days.

The same process occurs in the Southern Hemisphere, but with the opposite seasons: when it's summer in the North, it's winter in the South, and vice versa.

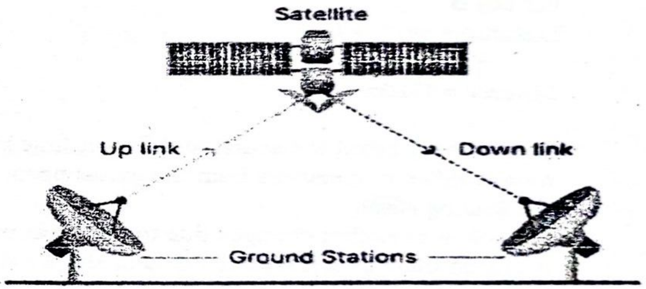
This combination of axial tilt and orbital path creates the cyclical pattern of seasons, which has a profound impact on our climate, weather, and daily lives. This is why it was raining in the other place and at the same time shinning in another hence the places were experiencing different seasons.

b) How the night in that outside country was day in their area at that same time.

Day and night are due to the Earth rotating on its axis, not its orbiting around the sun.
When the Earth rotates a given part facing the sun, that part experiences day and when that Earth's part faces away from the sun, then that part experiences night.
Daytime is when you can see the sun from where you are, and its light and heat can reach you.
Night time is when the sun is on the other side of the Earth from you, and its light and heat don't get to you. We get day and night because the Earth spins (or rotates) on an imaginary line called its axis and different parts of the planet are facing towards the Sun or away from it.

c) how T.V signals broadcast from where the floods were happening reached them.

TV stations or providers transmit their programs to satellites directly that are always in a fixed position with respect to the earth. These satellites receive the signals and retransmit them back to Earth.



Viewers with satellite dishes and receivers can pick up these signals, the decoder converts the signals into images & sound and then display the TV channels on the screens. This technology allowed learners to watch a wide range of channels and programming options accessible and that is how they viewed the floods.

Item 4

(a) understand more types of those identified satellites and why they exist there.

Artificial satellites are classified into various types by their function since they are launched into space to perform a specific function as listed below:

1. Communication Satellites:
   - Purpose: To transmit and receive signals for communication purposes.
   - Examples: GPS satellites for navigation, weather satellites for forecasting, and TV satellites for broadcasting programs.
2. . Observation Satellites:
   - Purpose: Observe and gather data about Earth's surface, weather patterns, and environmental changes.
   - Examples: Environmental monitoring satellites.
3. Navigation Satellites:
   - Purpose: Provide accurate positioning and navigation services.
   - Examples: GPS (Global Positioning System) satellites used in smartphones and navigation devices.
4. Weather Satellites:
   - Purpose: Monitor weather patterns, track storms, and provide data for weather forecasts.
   - Examples: GOES (Geostationary Operational Environmental Satellite) series used by meteorologists.
5. Spy Satellites:
   - Purpose: Gather intelligence and surveillance information for military and security purposes.
   - Examples: KH-11 series used for reconnaissance by governments.

b) Solve the problem of operation of security lights manually.

Challenge: Switching on and off of security lights

Remedy: The remedy here can be to install motion sensors that switch on very blinding lights and turn on buzzer shortly if a person does not verify themselves.

Conditions for the operation of the motion sensor

- If no one is detected, lights stay off, alarm system stays off.
- If a person is detected and identity is verified, the alarm system stays off.
- If a person is detected but the identity can't be verified, then the alarm system be switched on.

The truth table for the above conditions can be shown below:

- Detecting a person is A, O representing absence while 1 represents a correct identity.
- Alarm status is C,0 representing off while 1 represents on.

Truth table

A	B	C
1	1	0
1	0	1
0	1	0
0	0	0

Item 5

(a) The sun generates energy primarily from a nuclear fusion reaction.
In the sun's core, hydrogen nuclei (lighter nuclei) combine to form a helium nucleus. (of large nucleus) and this process occurs with release of the radiant energy called nuclear energy This occurs at extremely high temperatures and pressure
The sun coverts the nuclear energy to light and heat energy

(b) The energy received from the sun is majorly solar energy. This energy helps to support natural processes on earth such as photosynthesis, transpiration, germination, rainfall formation and evaporation.
These processes help in survival of both plants and animals as they transform energy to food.
Solar energy from the sun can still be harnessed to generate electricity to run factories, industries and other activities.

(c) The seasons occur due to tilting of the earth on its axis relative to its orbital plane around the sun there by receiving varying amounts of sunlight, leading to changes in temperature and weather patterns
The earths orbital path is elliptical hence its position and distance from the sun varies throughout the year giving rise to seasons.

The likely stages that average stars like the sun may undergo to die as wished by people are;
Red giant ⟶ planetary nebula ⟶ white dwarf

Nuclear models and nuclear process

Item 6

Item 6

(a) Background Radiation =30 counts per minute
Corrected count rate $A_0 = (550 - 30) = 520$
Half life , $t_{\frac{1}{2}} = 25\ minutes$
$520 \rightarrow 260 \rightarrow 130 \rightarrow 65.$

New reading from the detector $= (65 + 30) = 95$ *counts per minute*

The time $T = (25X3) = 75$ *minutes*

(b) (i) At the power plant, the nuclear process is nuclear fission. Nuclear fission is a nuclear reaction in which the nucleus of a heavy atom splits into two light nuclei with the release of energy and several neutrons. Fission can be spontaneous (occurring at random) or stimulated (induced) by bombarding (hitting) the nucleus by an incident neutron causing it to undergo fission.

(ii) Radiations emitted at nuclear power plant include:

- Alpha particles
- Beta particles
- Gamma rays (electromagnetic radiations)
- Neutrons

Properties of radiations

ALPHA	BETA	GAMMA RAYS	NEUTRONS
• Heavier than beta particles $6.64x10^{-27}kg$	• Are lighter than Alpha particles $9.1x10^{-31}kg$	Have no mass	Have a mass of $1.67x10^{-27}kg$
• Least penetrating power	Higher penetrating power than alpha particles	Higher penetrating power than beta particles	Higher penetrating power than gamma rays
• Are positively charged	Are negatively charged	Have no charge	Have no charge
• Are deflected by both electric and magnetic field	Are deflected by both electric and magnetic field	Are not deflected by both electric and magnetic field	Are not deflected by both electric and magnetic field
Have the highest ionising power	Have a high ionising power than gamma	Lower ionizing power than beta particles	Have high ionising power similar to alpha particles
Travel at a speed of $3x10^7$	Travel at different speeds	Travel at a speed of light in a vacuum	Travel at different speeds

(c) <u>Differences between alpha particles ,beta particles ,gamma rays ,neutrons and X-rays</u>

General properties of X-rays

- Travel at a speed of light
- Have no charge

- Not deflected by electric or magnetic fields
- Ionise gases and some metals through which they pass
- Affect photographic films
- Causes photoelectric emissions
- Causes fluorescence of crystals
- Have short wavelength and highly penetrate through materials

Task: Study the properties of the X-rays, compare them with the properties of radiations outlined above and generate differences.

(d) Guide was right to stop them because the radiations can cause the following;

- Radiations cause blood cancer(leukemia)
- Cause skin burn
- Cause sterility (inability to produce a child)
- Cause gene mutation
- Cause blindness
- Killing body cells
- Long time of exposure can increase risks of heart disease and stroke

Radiation sickness symptoms include;

- Nausea
- Vomiting
- Diarrhea
- Reduced white cell blood count
- Severe cases may lead to bone marrow failure

Protective measures

- Personal protection by wearing gloves and lead coats
- Minimize time spent, distancing from radiation sources
- Use appropriate shielding materials
- Radiation monitoring by using detectors to monitor exposure level to ensure they stay in safe limits
- Avoid eating or drinking when the radiation machine is operating
- Administration of treatments such as potassium iodide iodide to block radioactive iodine uptake by thyroid gland.

Item 7

(a) From $\lambda = \frac{v}{f}$

$$\lambda = \frac{3 \times 10^8}{6 \times 10^{18}}$$

$= 5 \times 10^{-11} m$

The resolution of the image is high

(b) Relationship between frequency, wavelength and penetrating power

The shorter the wave length the higher the frequency hence high penetrating power

The longer the wave length the lower the frequency hence low penetrating power

Choice of setting for the arm and dental exams

To image the bones and joints in the arm, hard x-rays are commonly used since they have higher penetrating power and high energy

The high energy allows for clear images of dense bone structures

Dental imaging

Hard x-rays are used dental radiography to capture detailed images of teeth and jaw.

(b) Precautions taken while using x-ray machines

- Limit exposure time. only use x-rays when medically necessary and keep exposure time as short as possible.
- Use of lead shields. Apply lead aprons, gloves to protect against scatter radiation
- Distance and shielding, the operator should maintain an appropriate distance from the x-ray source when possible

(b) Safety precautions of x-ray machines

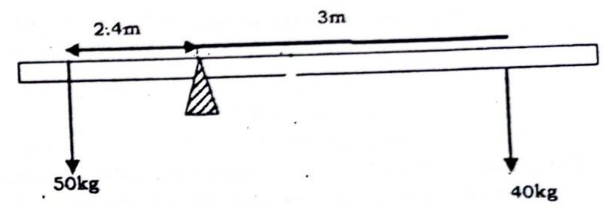
- Regularly check and record dosimeter readings to ensure remains with in safe limits
- Proper positioning. Ensure the patient is correctly positioned to minimize the number of repeat exposures needed for clear image
- Equipment maintenance. Calibrate the machines periodically to ensure accurate dosage and image quality. Also regularly inspect and maintain x-ray equipment to ensure it is functioning correctly and safely.
- Signage and access control. Put warning signs indicating the presence of x-ray equipment and radiation hazards.
  Restrict access to the x-ray room to authorized personnel only during imaging procedures
- Pregnancy and child safety. Take extra precautions for pregnant patients and children, as they are more sensitive to radiation
- Beam collimation. Use collimators to narrow the x-ray beam and reduce scatter.
- Cuts on the body should be curved.

ITEM 8

Heat and mechanics

ITEM 9

(a) Boy of mass = $50kg$



At equilibrium;
Sum of anti-clockwise moments = sum of clockwise
Clockwise moments = $(40\times10\times3)$
$= 1200Nm$
Anti-clockwise moment= $(2.4\times50\times10)$
$= 1200Nm$
Since the clockwise moments are equal to the anti-clockwise, then equilibrium will be restored.

(b) The heavy black shorts absorb heat from the sun and surrounding more efficiently than white vest. This increased heat absorption helps evaporate moisture faster.
The thatched roofs have trapped air within it which acts as an insulator. Hus keeping the house cool.

(c) Initial temperature, $\theta_1 = 42^0C$
Final temperature, $\theta_2 = 22^0C$
$Q = mc\Delta\theta$
$Q = 50 \times 3500 \times (42^0C\text{-}22^0C)$
$Q = 50 \times 3500 \times (20)$
$Q = 3{,}500{,}00\,J$

ITEM 10

a) Rate at which the pump works = work output per unit time

$$\text{power out put} = \frac{\text{mass x acceratiom due to gravity x height}}{\text{time}}$$

$$= \text{volume per second x densityx acceleration due to gravity x height}$$

$$= \frac{0.188}{60} \text{x} 1000 \text{x} 10 \text{x} 6$$

power out put = 188 W

$$\frac{\text{power out put}}{\text{power input}} = \frac{188}{240} = 0.78 > 0.75$$

$$\text{The efficiency of the pump} = \frac{\text{power out put}}{\text{power input}} \text{x} 100\%$$

$$= 0.78 \text{x} 100\%$$

= 78 % hence the pump is efficient.

b) During the day when the sun heats the ground and the ground temperature is warmer than water, it can warm the water as it sits in the well overnight.
The water in the well is insulated by the ground around it (poor conductor of heat), this insulation helps water to retain heat especially during the night when the air temperature is cooler
As a result the water can absorb heat from the ground and due to its high specific heat capacity of $4200Jkg^{-1}K^{-1}$. It loses heat slowly and thus feels warm in the morning.

c) Heat required to turn water into vapor is latent heat of vaporization.

heat = mass x specific latent heat of vaporisation

$$\text{heat} = \frac{500}{1000} \text{x } 2.56 \text{x} 10^6$$

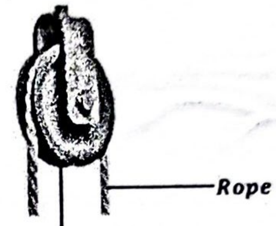
heat required = 0.5 x $2.56\text{x}10^6$

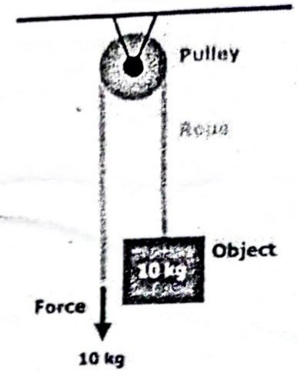
heat required = $1.28\text{x}10^6$J

ITEM 11

Expected responses

a) **Design:** A pulley is a wheel with a grooved rim on which a rope passes.





How it works.

This type of pulley system is a single fixed pulley; the pulley is fixed on the rigid support the load is tied to one end of the rope and the effort applied to another end of the rope. As the rope is pulled downwards, the load is raised upwards. Therefore, a single fixed pulley eases work because it changes the direction of the application of the effort.

b) Heat generated in the rope = potential energy gained

heat = mgh

heat = 20x10x17

heat = 3400J

Since the heat generated in the rope is less than the thermal strength of the rope of 38000Jtherefore the rope will not break.

The rise in temperature of the rope

heat generated = heat capity x rise in temperature

$$3400J = (mc)\Delta\theta$$

$$\Delta\theta = \frac{3400}{1870}$$

$$\Delta\theta = 1.82°\text{C}$$

c) High tensile strength. High tensile strength enables a rope to withstand a load when in tension.

ITEM 12

a) Cooking equipment like saucepans are normally made out of aluminum, copper and steel due to their low specific heat capacity.

Therefore, steel and aluminum can be used to make saucepan and their covers (lids). Steel and aluminum are both ductile materials with the ability to be hammered, bent, rolled, molded and stretched into different shapes without breaking.
They also have a high tensile, compressional and thermal strength.

To guarantee safety, handles of equipment especially those dealing with heat are normally made with, materials of a high specific heat capacity such as rubber and wood to resist heat increase. Therefore, the handles of ladles can be made out of wood.

The cups and plates can be made from melamine material or clay. This is because both are poor conductors of heat however, clay is very brittle and may not be suitable for school children. Melamine has a very high thermal strength, it is light and it does not break easily. This makes it more suitable.

b) Aluminum and steel are good conductors (metals) of heat.
Good conductor of heat conduct heat easily because they are made up of atoms with freely electrons which are loosely bound. When heat is supplied to a solid conductor the particles of the metal acquire kinetic energy and vibrate more violently and this weakens the intermolecular forces.
Bad conductors of heat like wood, glass and melamine do not conduct heat easily because they are not made up of free electrons.

Conduction is faster in good conductors than in bad conductors and different conductors have different rates of conductivity

Electricity and magnetism

Item 13

From $P = IV$

$$I_1 = \left(\frac{75}{120}\right)$$

$= 0.625A$ and

$$I_2 = \left(\frac{600}{120}\right)$$

$= 5A$

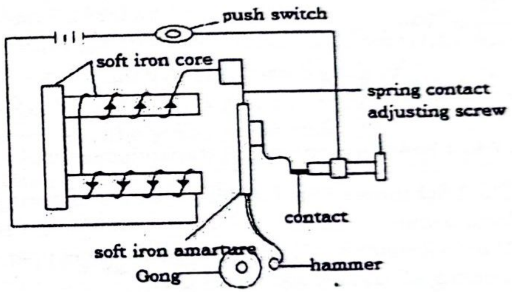
Total current = 5+0.625

=5.625A

Hence the extension will not support the two appliances since $5A \leq 5.625A$

(a) Bulbs in his house should be connected in parallel since parallel connections have the following advantages.
- Bulbs operate at the same voltage.
- If one bulb gets faulty, others continue operating
- Bulbs can easily be operated independently.

(b) Illustration of an electric bell



How it works

- When the switch is closed, current flows through the circuit, and the soft iron core is magnetized
- It then attracts the soft iron armature which then makes the gong to be hit by the hammer there by producing a loud sound.
- As the armature is attracted, the contact between the spring and the contact screw is broken thus the current is cut off and the electromagnet is demagnetized
- The spring then returns to the original position and makes the hammer hit the contact again
- The process is repeated and the hammer hits the gong repeatedly making continuous ringing sound as long as the switch is pressed.

(c)

Item 14

(a) By means of a device called a step up transformer that increases voltage from 12Kv to 400kv. This can be achieved by having many turns in secondary coil than in primary coil.

(b) A.C from the dam is converted to D.C by using rectifiers(diodes) and then D.C is used to charge mobile phones effectively.

(c) From

$effeciency = 100\% - percentage\ of\ lost\ power$

$= 100\% - 10\%$

$= 90\%$

also

$$effeciency = \left(\frac{power\ output}{power\ input}\right) \times 100$$

$$effeciency = \left(\frac{power\ in\ secondary\ coil}{power\ in\ primary\ coil}\right) \times 100$$

$$\frac{90}{100} = \frac{I_S V_S}{I_P V_P}$$

$$I_S = \frac{90 \times 20 \times 12 \times 10^3}{400 \times 10^3 \times 100}$$

$I_S = 0.54A$ hence the current in transmission cable is $0.54A$

(d) The brightness of the bulb faded due to defects such as polarization and local action

Due to formation of hydrogen gas at the copper rod and the gradual wearing of the zinc rod respectively.

The brightness can be restored by minimizing;

- Polarization by use of depolarizers such as potassium per magnate or manganese dioxide which oxidizes hydrogen to form water. It can also be minimized by occasionally brushing the anode.
- Local action can be minimized by using pure zinc or rubbing the zinc rod clean using mercury (amalgating zinc) or by cleaning the zinc rod using concentrated sulphuric acid.

item 15

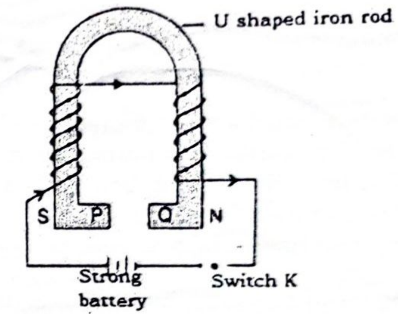
(a) The attendant should increase the strength of magnetic field so that it corresponds to increased weight of tanks by,

Increasing the current

Increasing the number of turns

Alternatively

Set up the u shaped bar to a dry cell as shown below



- A u-shaped steel bar is connected to a strong current source as shown above
- The current is switched on for a few minutes and then off
- The current flowing in the same direction makes the atomic magnetism the domain to point in the same direction
- The iron rod in presence of a strong current source, a strong magnetic field will be produced necessary to lift the heavy metals

(b) Tanks were found attracted to each other because they got magnetized by,

- Induction
- Contact or touch as they get closer

(c) Tanks can be separated by

- Heating until it turns red hot and cooled in the East west direction
- Dropping
- Hammering
- Using alternating current

Item 16

(a) The above design is a simple transformer that will step down 240v to 120v

- 240v from the generator is applied on the receiving part (primary coil) of the coil and the alternating current flows
- This current sets up a changing magnetic field in the soft iron core which links up in the secondary coil (output part)
- An Emf induced in this coil that corresponds to 120v and is proportional to the number of turns

(b) From

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$\frac{120}{240} = \frac{N_s}{300}$$

$$= 150\ turns$$

(c) $effeciency = \left(\frac{power\ output}{poer\ input}\right) \times 100$

$$= \frac{I_S V_S}{I_P V_P} \times 100$$

$$= \frac{120 \times 1.5}{240} \times 100$$

$$= 75\%$$

Practical expected items

Item 1 (Mechanics)

Aim of the experiment: To determine spring constant.

Hypothesis: The spring constant is 25 Nm^{-1}

Variables:

- Independent variable: mass hanging at the lower end of the spring
- Dependent variable: extension produced by the mass.
- Controlled variable: wind.

List of apparatus:

- 1 retort stand with a clamp.
- 2 pieces of wood each about 4.0 cm long, 4.0 cm wide and 1.0 cm thick.
- 1 pointer.
- 6, 100 g slotted masses.
- 1 metre rule.
- 1 helical sprin

Procedure

(a) The experiment is set up as shown in Figure 1.0

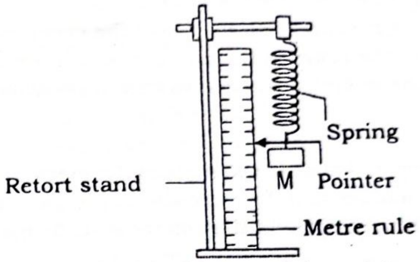


Figure 1.0

(b) The initial position x_0 of the pointer on the metre rule is read and recorded.

(c) A mass M = 0.100 kg is suspended from the spring.

(d) The new position x of the pointer on the metre rule is read and recorded.

(e) Procedures (c) and (d) are repeated for values of M = 0.200, 0.300, 0.400, 0.500 and 0.600 kg.

(f) The results are recorded in a suitable table including values of extension $e = (x - x_0)$ in metres and force F = Mg in Newton.

(g) A graph of F against e is plotted.

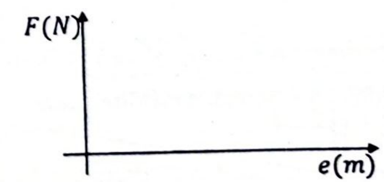
(h) The slope k of the graph is determined.

Theory of the experiment

From Hooke's law,

$$F = ke \ ..... \text{(i)}$$

Equation (i) is of the form $y = mx$, the equation of a straight line with gradient (or slope) m = $s = k$. The term F in equation (i) corresponds to y in the equation of a straight line and therefore, this should be written along the vertical axis. Corresponding to x in the equation of the straight line is the term e and this is what should be indicated on the horizontal axis as shown below



Hence, the spring constant k is the gradient or slope of the graph.

Sources of errors

- Non uniform calibration of the scale of the metre rule used to measure values of the initial and new positions of the pointer.
- Leaving the masses hanging on the spring long after reading the new position of the pointer.
- Parallax error. This results when the eye of the experimenter is not directed normal to the scale on the metre rule. The small gap between the pointer and the metre rule also results in a parallax error.

Precautions

- Direct the eye perpendicular to the scale of the metre rule when taking readings from it in order to reduce the size of the parallax error. Also make sure that the gap between the pointer and the metre rule is very small.
- Remove the load from the spring every after taking the new position of the pointer on the scale of the metre rule. This ensures that the spring does not undergo plastic deformation.

Item 2 (Light)

Aim of the experiment: To determine focal length f of a concave mirror.

Hypothesis: The focal lengths of the concave mirrors are in the range 15.0 cm to 20.0 cm

Variables:

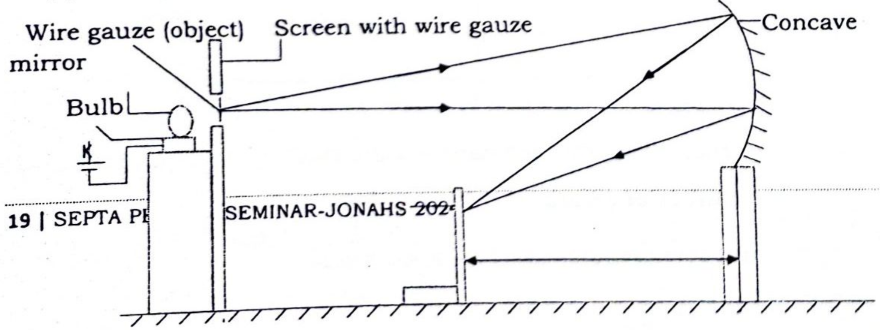
- Independent variable: distance u, of object from the lens.
- Dependent variable: distance v, of image from the lens.
- Controlled variable: intensity of light

List of apparatus:

- Convex mirrors
- 1 mirror holder
- 1 screen with wire gauze
- 1 white screen
- 1 torch bulb
- 2 dry cells
- 1 double cell holder
- 1 switch
- 3 connecting wires

Procedure.

(a) The experiment is set up as shown in figure 2.0



White screen

v

u

Figure 2.0

(b) Distance u between the wire gauze (object) and the mirror is adjusted to 15.0 cm
(c) The switch is closed.
(d) The white screen is moved until a sharp image of the object is formed on it.
(e) The image distance v is measured and recorded.
(f) The switch is opened.
(g) Procedures (b) to (e) are repeated for values of u = 20.0, 25.0, 30.0, 35.0 and 40.0 cm
(h) The results are tabulated including values of $(u + v)$ and uv.
(i) A graph of uv against $(u + v)$ is plotted.
(j) The slope f of the graph is determined.

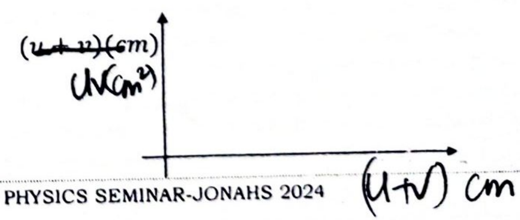
Theory of the experiment

Using the mirror formula $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$$\frac{1}{f} = \frac{u+v}{uv} \text{ or}$$

$$(u + v) = \frac{1}{f}(uv) \text{ .... (i)}$$

Equation (i) is of the form $y = mx$, the equation of a straight line with gradient (slope) m = $s = \frac{1}{f}$. The term $(u + v)$ in equation (i) corresponds to y in the equation of a straight line and therefore, this should appear along the vertical axis. Corresponding to x in the equation of the straight line is the term uv and this is what should be indicated on the horizontal axis as shown below.



$uv(cm^2)$

Hence, the focal length f is calculated using the equation $f = \frac{1}{s}$.

Sources of errors

- Non uniform calibration of the scale of the metre rule used to measure distances u and v.
- Failure to get equally sharp images of the wire gauze for the different values of u
- The cells (source of light), cannot give equally bright light from the beginning to the end of the experiment, therefore affecting the clarity of the image on the screen.
- Parallax error. This results when the eye of the experimenter is not directed normal to the scale on the metre rule.

Risks

The concave mirror used is fragile and can cause injuries if broken.

Precautions (mitigations)

- A bright source of light should be placed a short distance away from the wire gauze (the object) so as to obtain a sharp image of it on the screen.
- The mirror should be placed in front of the illuminated wire gauze and the screen in front of the mirror so that all the three are in a straight line.
- To avoid parallax errors, measurement of the object and image distances is done in such a way that the experimenter's eye in directed normal to the scale of the metre rule. [Positioning the eye to 90° to the value are reading.
- The metre rule used to measure the object and image distances has two scales. Only one of the scales (which is not upside down) should be used.

Item 3 (Electricity)

Aim of the experiment: To determine resistance of a filament bulb

Hypothesis: Resistance of the bulb's filament is not greater than 1.0 Ω

Variables:

- Independent variable: length l of wire

- Dependent variables: current I flowing through the bulb, potential difference V, across the bulb.
- Controlled variable: temperature of the bulb's filament.

List of apparatus:

- 1 new dry cell (of 1.5 V)
- 1 single cell holder.
- 1 switch labelled K
- 1 ammeter (0 – 1 A)
- 1 voltmeter (0 – 3 V)
- 8 connecting wires
- 1 metre rule
- 2 pieces of cello tape
- 2 crocodile clips
- 1 piece of bare wire (constantan SWG 28) of length 110.0 cm

Procedure

(a) A circuit is set up as shown in Fig 3.0

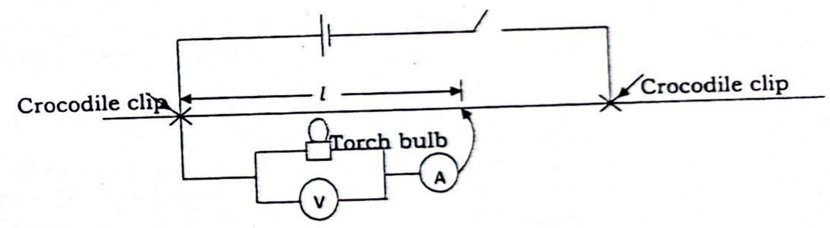


Figure 3.0

(b) Starting with l = 0.200 m, switch K is closed.
(c) Readings V and I of the voltmeter and ammeter respectively are recorded.
(d) Switch K is opened.
(e) Procedures (b) to (d) are repeated for values of l = 0.300, 0.400, 0.500, 0.600 and 0.700 m
(f) The results are tabulated.
(g) A graph of V against I is plotted.
(h) The slope r of the graph is determined and is the resistance of the bulb's filament.

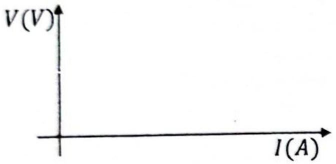
Theory of the experiment

From Ohm's law,

$$V = rI \;.....\; \text{(i)}$$

Where r is the resistance of the bulb's filament

Equation (i) is of the form $y = mx$, the equation of a straight line with gradient (or slope) $m = r$. The term V in equation (i) corresponds to y in the equation of a straight line and therefore, this should be written along the vertical axis. Corresponding to x in the equation of the straight line is the term I and this is what should be indicated on the horizontal axis as shown below



Hence, the resistance r of the bulb's filament is the gradient or slope of the graph.

Sources of errors

- Non uniform calibration of scales of the metre rule, ammeter and voltmeter used to measure length l, current I and potential difference V.
- Parallax errors in measuring length l, current I and potential difference V.
- Ammeter and voltmeter readings drift over time.
- Gradual running down of the dry cell used
- Twisting connecting wires increases resistance in the circuit
- The ammeter and voltmeter may warm up, making them to give varying reading.
- Loose contacts at the terminals of instruments (e.g. ammeter and voltmeter) and at junctions.

Risks

- The connecting wires used in the circuit have live wires covered by an insulation. The tiny live wires can cause injury by pricking if they are not twisted with care when setting up the circuit.

Precautions (mitigations)

- To avoid parallax errors, measurement of current and potential difference should be done in such a way that the experimenter's eye in directed normal to the scales of the instruments.
- Since the dry cell gradually runs down, switch the current off before changing to the next value of l.

Conclusion

The resistance of the torch bulb filament is either equal to or greater or less than 1.0 Ω

Advice: If the resistance of the torch bulb filament is greater than 1.0 Ω, then they are not as good as those supplied the previous term and should have been rejected by the school.