NEW LOWER SECONDARY CURRICULUM PHYSICS PRACTICAL

INTRODUCTION

1. The new curriculum physics practical assessment consists of only two (2) scenario questions, from either Mechanics, light or electricity and a learner attempts only one question.
2. The duration for this exam is strictly 2 hours.
3. The steps in a scientific investigation are;
    - observing a situation,
    - identifying a problem or question,
    - identifying variables involved,
    - formulating a hypothesis,
    - designing and carrying out an experiment,
    - collecting and tabulating data,
    - writing a report for the investigation.

INDICATORS FOR PHYSICS SCIENTIFIC INVESTIGATION

The learner must write a practical work report which will include the following;

(a) Aim of the scientific investigation (experiment).

(b) Variables of the experiment
- Independent variable
- Dependent variable
- Controlled variable

(c) Hypothesis

(d) List of apparatus and materials

(e) Procedure of the experiment and setup

(f) Presentation of data
- Table of results
- Graphs
- Calculation of the slope

(g) Sources of errors

(h) Precautions

(i) Conclusion; conclusions can come from the value of the graph, the value of the slope or intercepts etc.

Note:

The conclusion will either qualify or disqualify the hypothesis. It is the conclusion that shows that whether the hypothesis is correct or not.

FORMULATING A HYPOTHESIS

- ✓ The hypothesis is a concept or an idea that is to be tested through research and experiments.

OR: A hypothesis is the prediction about what the scientific investigation will find.

OR: It's simply a statement that is to be proven at the end of the scientific experiment or investigation.

- ✓ It shows the relationship between one dependent variable and a single independent variable.

IDENTIFYING VARIABLES INVOLVED

There are three (3) basic types of experimental variables that a learner must identify and note down while performing a scientific investigation in physics practicals. And these include;

Independent/Manipulated Variable

- ✓ This is a variable that we can change or control in a scientific experiment or investigation.

OR: This is a variable which the experimenter (or investigator) changes to test its dependence on other variables.

Dependent variable/Responding variable

- ✓ This is the one which we can test in a scientific investigation in order to get results.
- ✓ The dependent variable depends on the independent variable.
- ✓ When taking data during a scientific investigation, the dependent variable is the one being measured.

Controlled/Fixed/Control variable

- This is the one the investigator/experimenter holds constant during a scientific investigation.
- The control variable is not part of an experiment, but it is important because it has an effect on the results.
- One of the most common control variables is ***temperature***, and if not taken account of it might nullify the correlation between the dependent and independent variable. Other control variables include; ***amount of light***, ***humidity***, ***wind speed***, ***duration of an experiment*** etc.
- Whenever it is possible, control variables should be identified, measured and recorded.

WORKED OUT SCENARIOS

Scientific investigation 1

An old man and his grandson, who had grown up with his parents in the city, were very hungry after working in a garden. While resting under a mango tree, a ripe mango fell from the tree. The grandson got excited and wanted to get more mangoes to eat before proceeding home for lunch, but he was not sure of a quick way to harvest the ripe mangoes from the tree. The grandfather advised that if he could climb up the tree and shake the branches, the ripe mangoes would fall to the ground. The grandson did exactly that and many ripe mangoes fell to the ground, which he ate with his grandfather. The grandson then told his grandfather that their physics teacher told them that mangoes fall from trees because of the force of gravity acting on them. He added that the teacher had also told them that bodies fall freely at the rate of 10 ms^{-2}. The old man, being curious, wanted to know how the teacher arrived at his rate. He challenged the grandson to prove to him that indeed bodies fall freely at the rate of 10 ms^{-2}. However, the grandson did not know how to prove this to his father.

Task

As a physics learner and using the set up above, help the grandson to practically verify and show the grandfather that bodies fall freely at a rate of 10 ms^{-2}.

Hint

The relationship between the period, T, of oscillation and the length, l, of a pendulum is given by $T^2 = \left(\frac{4\pi^2}{g}\right) l$.

Apparatus

3 masses of 100 g, 1 mass of 50 g, 1 spring with a pointer, 1 metre rule and 1 retort stand with 2 clamps

Response

Aim of the experiment;

An experiment to determine the value of acceleration due to gravity.

Variables;

- Independent variable; length l.
- Dependent variable: time, t for 20 oscillations, period T and T^2
- Control variable; wind speed and reaction time.

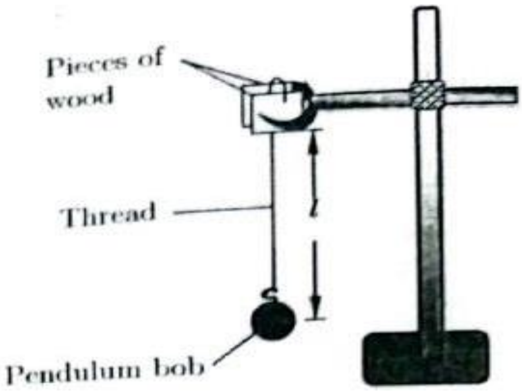
Hypothesis; Acceleration due to gravity, g=10 ms^{-2}.

List of apparatus;

1 piece of thread of length 110.0 cm, 1 pendulum bob, 1 metre rule, 1 retort stand with a clamp, 1 stop clock or stop watch, 2 small pieces of wood.

Procedure:

(a) The pendulum bob is suspended by means of a thread from a retort stand as shown in the figure below.



(b) The length, l, of the pendulum is adjusted to 0.900m

(c) The bob is displaced sideways through a small angle and released to oscillate

(d) The time, t for 20 oscillations is determined and recorded.

(e) Procedures (b) to (d) are repeated for l = 0.800, 0.700, 0.600, 0.500 and 0.400 m.

(f) The results are tabulated in a suitable table including the values of time T for one complete oscillation and T^2.

(g) A graph of T^2 against l is plotted.

(h) The slope, S, of the graph is then calculated.

(i) The value of acceleration due to gravity, g, is got from the expression $g = \frac{4\pi^2}{S}$, where S is the slope of the graph.

Risks/errors

- Inconsistence in timing of the oscillations i.e poor timing
- Inaccurate measurement of length l of the pendulum.
- Elliptical oscillations caused by shaking of the retort stand.
- Non-uniform oscillations due to wind disturbance.

Mitigation/ precautions

- ✓ Disturbance due to wind can be avoided by switching off the fans and closing windows and doors.
- ✓ Ignore the first few oscillations and start timing only when oscillations are steady.

- ✓ Make sure the angle through which the pendulum swings during timing is small.
- ✓ Always give the pendulum bob a small displacement.
- ✓ The length of the pendulum should be measured from the point of suspension to the centre of the bob.
- ✓ When the oscillations of the pendulum become elliptical, stop timing and displace the pendulum bob again.

Table of results

$l(m)$	$t(s)$	$T(s)$	$T^2(s^2)$
0.900	38.02	1.902	3.618
0.800	35.59	1.780	3.168
0.700	33.28	1.664	2.769
0.600	31.12	1.556	2.421
0.500	28.25	1.413	1.997
0.400	25.40	1.270	1.613

From the graph

$$S = \frac{3.70-1.56}{0.93-0.39} = \frac{2.14}{0.54} = 4.0s^2m^{-1}$$

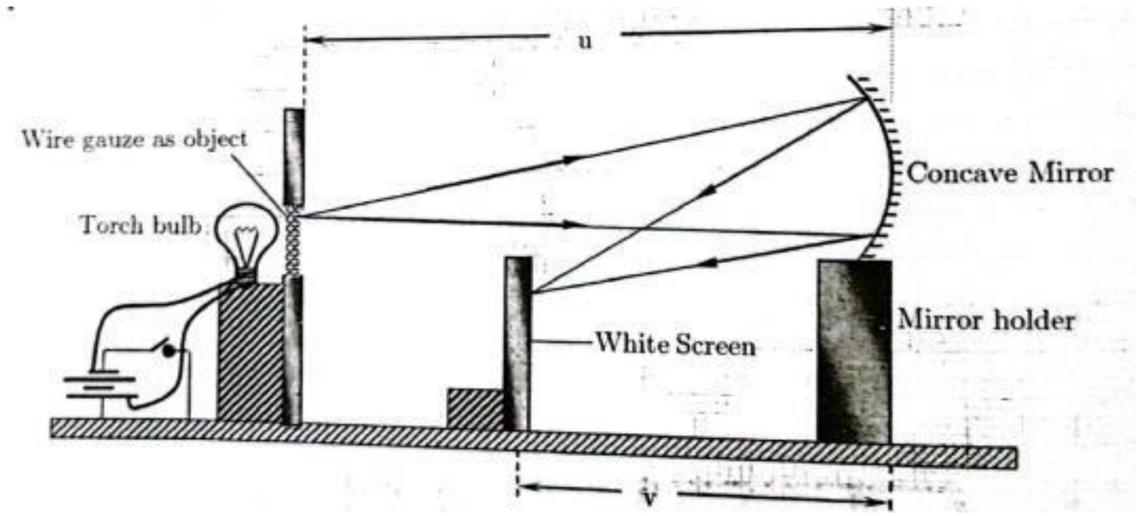
$$From\ g = \frac{4\pi^2}{S} = \frac{4\pi^2}{4.0} = 9.9ms^{-2}$$

A graph of T^2 against l

Scientific investigation 2

Last week, Peter visited his elder brother, whom he found using a concave mirror as a shaving mirror. To Peter's amazement, his image in the mirror was bigger. When he returns home, he decided to buy a concave mirror and use it as his shaving mirror, instead of a plane mirror. The following day, Peter went to a mirror shop, whose attendants asked him for the focal length of the concave mirror he wanted to buy but he could not specify it. After asking him the purpose for which he wanted the concave mirror, it was recommended that he buys concave mirror of focal length 10 cm but unfortunately, the available concave mirrors we are not labelled with their focal lengths. However, one of these concave mirrors had been packed together with an unlabelled smaller concave mirror of the same focal length. Since the shop attendants wanted to serve their client, they were determined to find the focal length of one of the mirrors, but did not have sufficient knowledge to do so.

Experimental set-up



Task:

As a physics learner, carry out a scientific investigation to determine the focal length of the sample concave mirror.

Hint: $(u + v) = f(uv)$

Apparatus

2 dry cells, a double cell holder, 1 torch bulb, 1 bulb holder, 1 switch, 1 concave mirror, 1 screen with a wire gauze, connecting wires, 1 metre rule and 1 screen.

Response

Aim of the experiment;

An experiment to determine the focal length of a concave mirror.

Variables;

- Independent variables; Object distance, u
- Dependent variable; Image distance, v
- Control variable; Amount of light

Hypothesis;
The focal length of the concave mirror is $10.0cm$.

List of apparatus;
2 dry cells, a double cell holder, 1 torch bulb, 1 switch, 1 concave mirror, 1screen with a wire gauze, connecting sires, 1 metre rule.

Procedure;

(a) The electrical circuit for lighting the bulb, the wire gauze, the concave mirror and the white screen are set up as shown above.

(b) The concave mirror is moved so that it is at a distance u=15.0 cm from the object

(c) The position of the white screen is adjusted until a sharply focused image I of the object appears on it

(d) The image distance v is measured and recorded.

(e) Procedures (c) to (e) are repeated for values of u =20.0, 25.0, 30.0, 35.0 and 40.0 cm.

(f) Obtained results are then entered in a suitable table including values of uv and $(u + v)$

(g) A graph of $(u + v)$ against uv is plotted.

(h) The slope S of the graph is determined

(i) The focal length f of the concave mirror is then calculated from the expression; $f = \frac{1}{S}$.

Table of results

$u(cm)$	$u(cm)$	$uv(cm)$	$(u+v)(cm)$
15.0	28.8	432	43.8
20.0	20.0	400	40.0
25.0	16.5	413	41.5
30.0	15.0	450	45.0
35.0	14.1	494	49.1
40.0	13.4	536	53.4

From the graph;

$S = \frac{56.2-37.0}{560-374} = \frac{19.2}{186} = 0.103$

$from\ f = \frac{1}{S} = \frac{1}{0.103} = 9.67\ cm$

A graph of $(u+v)$ against uv

Risks/errors

- ✓ Parallax errors in reading distances on the metre rule i.e inaccurate measurement of object and image distances.
- ✓ Failure to obtain a distinct and sharp image.

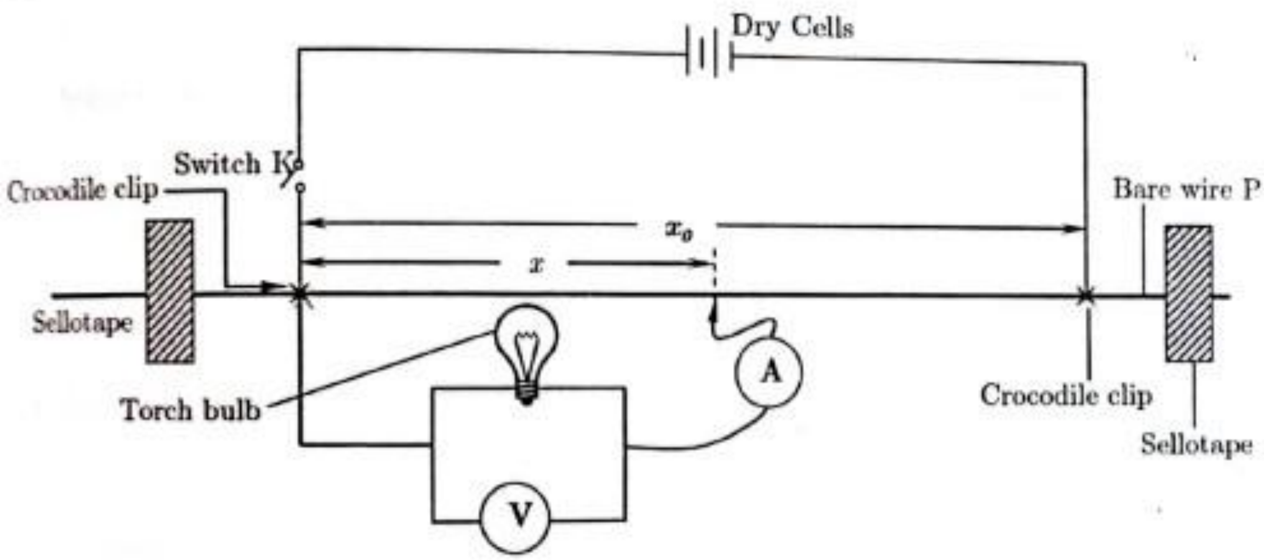
Mitigation/ precautions

- ➢ To get a well illuminated and distinct image of a distinct object, the object should be well illuminated.
- ➢ While placing the illuminated object, the object should be clearly visible.
- ➢ The image on the screen should be sharp and well defined.
- ➢ The polished surface of the concave mirror and the distinct object should face each other.
- ➢ When measuring image and object distances, the eyes must be exactly perpendicular to the point where the reading / measurement is to be taken to avoid parallax errors.
- ➢ If the ends of the metre rule are broken or damaged, we should avoid taking measurement from the ends to avoid zero errors.
- ➢ Always use correct scale and be consistent with the scale you are using.

<u>Scientific investigation 3</u>

A school was supplied with bulbs for laboratory use. When the laboratory technician tested the bulbs, he found out that they could light when connected to two dry cells but they produced dim light. He then tested some of the bulbs that had been supplied earlier and he was supplied by the results, he checked the newer bulbs supplied and he realized that they did not have specifications on them. He also observed that their filaments were not of the same size as those of the older bulbs. This prompted him to doubt whether the filaments of the newer bulbs supplied had the recommended resistance. However, he was very busy, the technician selected one of the bulbs and gave it to a learner to determine the resistance of its filament.

Experimental setup



Task

As a physics learner and using the experiment setup above, and assuming you are the learner who was selected by the laboratory technician, carry out a scientific investigation to determine the resistance of the bulb filament of the simple bulb.

Hint; $I = \left(\frac{1}{r}\right)V$

Apparatus

2 dry cells, 1 ammeter(0-1A), 1 voltmeter(0-3V), 1 torch bulb, constantan wire SWG28, connecting wires, 1 switch, 1 metre rule, 2 pieces of Sellotape, 2 crocodile clips and a double cell holder.

Response

Aim of the experiment;

An experiment to determine the resistance of the filament of the torch bulb.

Variables

- Independent variables: length, x
- Dependent variables: current I, voltage V.
- Control variables: temperature of bulb filament.

Hypothesis;

The resistance of the bulb filament is 1Ω

List of apparatus;

2 dry cells, 1 ammeter (0-1A), 1 voltmeter (0-3V), 1 torch bulb, constantan wire SWG 28, connecting wires, 1 switch, 1 metre rule, 2 pieces of Sellotape, 2 crocodile clips and a double cell holder.

Procedure;

(a) The bare wire P is fixed on the metre rule using the pieces of cellotape provided

(b) The circuit is connected as shown in the figure above

(c) Starting with length $x_0 = 1.000m$ and $x = 0.200m$, switch K is close.

(d) The voltmeter reading V and ammeter reading I are read and recorded

(e) Switch K is then opened

(f) Procedures (b) to (e) are repeated for values of x = 0.300, 0.400,0.500, and $0.600m$.

(g) Results obtained are recorded in a suitable table.

(h) A graph of $\frac{1}{I}$ against $\frac{1}{V}$ is plotted.

(i) The slope S of the graph is calculated.

(j) The resistance, r of the bulb filament is the calculated from $r = S$.

Table of results

$x(cm)$	$I(A)$	$V(V)$	$\frac{1}{I}(A^{-1})$	$\frac{1}{V}(V^{-1})$
0.200	0.08	0.10	12.5	10.0
0.300	0.10	0.15	10.0	6.7
0.400	0.12	0.25	8.3	4.0
0.500	0.14	0.35	7.1	2.9
0.600	0.16	0.45	6.3	2.2

From the graph

$$S = \frac{12.6 - 5.7}{10.1 - 1.1} = 0.77\ \Omega$$

From $r = S = 0.77\ \Omega$

A graph of $\frac{1}{I}$ against $\frac{1}{V}$

Risks/errors

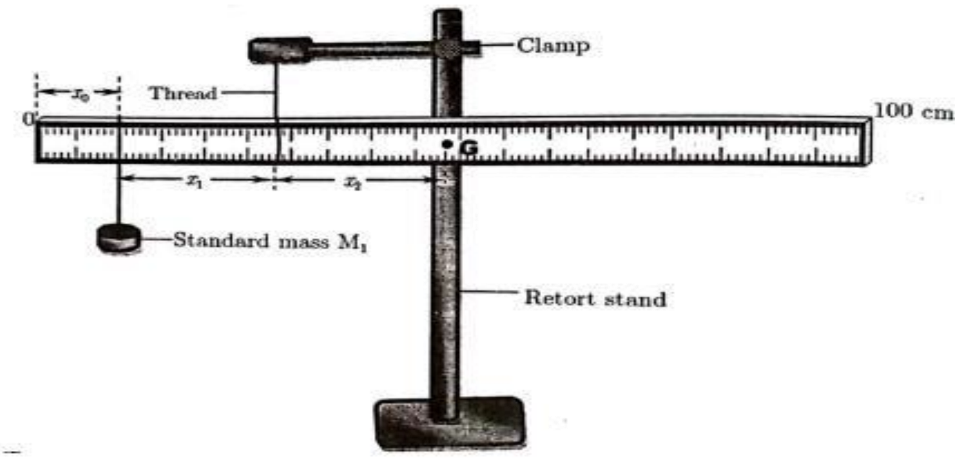
- ✓ Error in the current measurement.
- ✓ Error in the source voltage.

TRIAL SCENARIOS

Scenario 1

One of the requirements of the new lower secondary school curriculum is project work. Learners of physics in SHSM designed a uniform metre rule as their project. When their physics teacher looked at the metre rule they had designed, he was impressed and commended them for the good work. However, when the teacher asked them the mass of the metre rule they had designed, they couldn't tell him and there was no beam balance for them to use to measure. One of the learners came up with an idea on how to determine the mass of the metre rule. When he was given the opportunity by the teacher to determine the mass of the metre rule they had made using his method, he tried but the value he obtained looked too big and the teacher was not satisfied with the results.

Experimental setup



Task;

As a physics learner and using the arrangement of the apparatus above, carry out a scientific investigation to help the other learners determine the mass of the uniform metre rule they designed as their project work.

Hint; Principle of moments applies

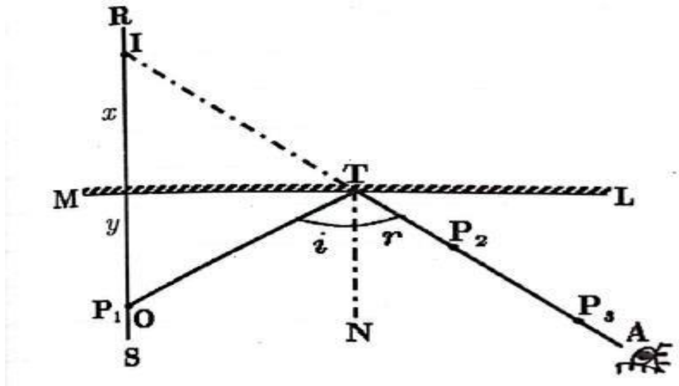
Apparatus;

1 uniform metre rule, 1 rectangular wooden block, 1 retort stand with a clamp, 5 masses each of 50g and 3 pieces of thread each 30 cm.

Scenario 2

Jane and her mother were dressing up to go for a wedding party. They went in front of a plane mirror while dressing up. Jane who is in S.3 told her mother that the distances of their images from the plane mirror was equal to the distance between them and the plane mirror. However, her mother disagreed claiming that their images were closer to the plane mirror than they are. Jane told her mother that their physics teacher told them that the distance of any object placed in front of a plane mirror forms its image at the same distance behind the plane mirror as the object is in front of the mirror. Jane's mother challenged Jane to prove it.

Experimental setup



Task

As a learner of physics and using the arrangement of the apparatus shown above, carry out a scientific investigation to show the relationship between the object distance and the distance of its image from the plane mirror.

Hint:

Laws of reflection apply

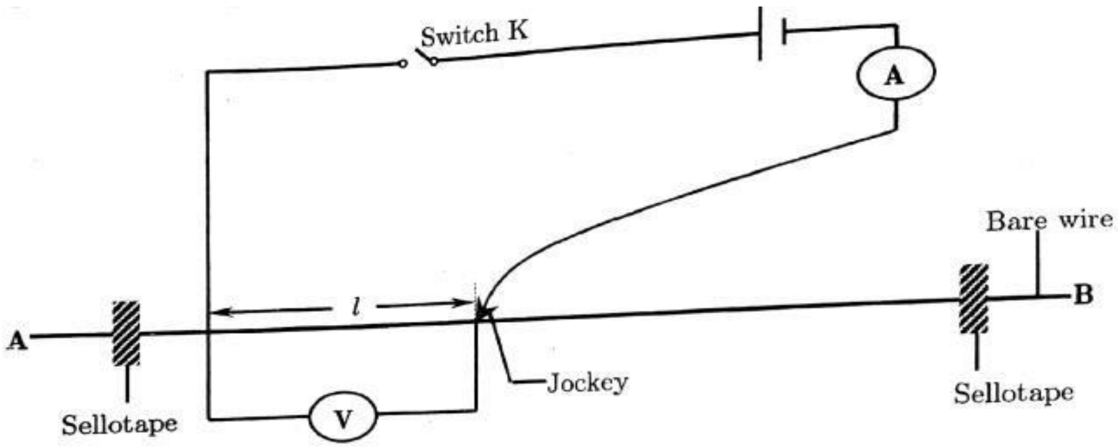
Apparatus

1 plane mirror, 1 white sheet of paper, 1 soft board, 4 optical pins, 4 drawing pins and a complete geometry set.

Scenario 3

A mechanic received a phone with a charging problem. When he assessed the phone, he realized that one of the wires on the charging system was disconnected. When he asked the phone owner what could be the problem, he was told that the problem started when the phone fell down. On hearing this, the mechanic replaced the disconnected wire with another one, but the phone could still not charge. This prompted him to reconnect the wire he had removed and to his surprise the phone started charging. The mechanic wondered why the wire he had added earlier could not rectify the problem. When he asked his fellow mechanics about it, they told him that it was because the wires have different resistivities and that the best wires for use in charging systems are those with low resistivity. The mechanic, therefore, decided to determine the resistivity of each type of wire in his work shop, but unfortunately, he did not have sufficient understanding of how to carry this out.

Experimental setup



Task

As a learner of physics and assuming you are the phone technician, carry out a scientific investigation to determine the resistivity of the specimen wire provided.

Hint;

$\frac{V}{I} = \left(\frac{\rho}{2.04\times10^{-7}}\right) l$, where ρ is the resistivity.

Apparatus;

1 dry cell, 1 ammeter(0-1A), 1 voltmeter(0-3V), 1 piece of constantan wire SWG30 and length 120 cm, 1 2Ω resistor, 8 pieces of connecting wires, 1 switch, 1 metre rule, 2 pieces of Sellotape, 2 crocodile clips, and 1 single cell holder.

Scenario 4

A driver had his driving mirror broken. He decided to replace it tentatively with a plane mirror instead. While driving, he realized something different from the mirror he was using at first. When a person is far behind his car, it appears too small and far. When the person is near the car, it is shown as a big and near image. This puzzled him. When inquired from a friend, he was told that a plane mirror, has a property which makes it hard to be used as a driving mirror, the image size and distance from the mirror are the same as object distance from the mirror. This confused the driver the more and prompted him to ask another fellow driver who was completely lost bust just told him don't use it anymore, that it is risky. In that state, the driver is seeking for a clear explanation.

Task:

Assuming the driver approaches you as a physics learner for clear explanations, carry out a scientific procedure to guide your explanation to him.

Hint:

Laws of reflection.

Apparatus:

1 plane mirror glued to a block of wood, 1 white sheet of paper, 1 soft board, 4 drawing pins, 4 optical pins and a complete mathematical set.

Scenario 5

While in his village, John has been using a plane mirror to aid him in shaving. One day, when he had gone on a visit to his elder brother in Kampala, he found out that his brother uses a concave mirror as a shaving mirror. When his brother wasn't at home, he picked that concave mirror and had a keen look through it. It surprised him that his image was bigger, nearer and upright. He then noticed that it would be easier to do shaving using a concave mirror. When he returned back to the village, he decided that he must buy a concave mirror for his shaving. The following day, John went to the nearby town to look for a concave mirror. After moving through several shops, he chanced one shop selling the mirrors. The shop attendant asked him for the focal length of the mirror he was looking for, but John could not tell. To help him get a suitable mirror, the shop attendant asked him what purpose he wanted the mirror for and he said it is for shaving. The shop attendant recommended that he must buy a concave mirror of focal length 10 cm. Unfortunately, there were two mirrors in the shop which had remained for which it was of 10 cm and 15 cm focal length. Since John badly wanted to back with the mirror having looked for it from several shops and also the fact that the attendant had not made any sales, they both decided that they find out the focal length of the mirrors in question, but they failed in the process.

Task:

As a physics learner, carry out a scientific investigation to determine the focal length of the mirror in question so as to help John and the attendant.

Hint:

Take use of the equation; $\frac{V}{U} = \left(\frac{1}{f}\right)V - 1$

Apparatus:

2 dry cells, a double cell holder, 1 torch bulb, 1 bulb holder, 1 switch, 1 concave mirror, 1 screen with a wire gauze, connecting wires, 1 metre rule and 1 screen.

END