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ORIGINAL EDITION

SURE DEAL PHYSICS

STUDENT'S PRACTICAL WORKBOOK

Centered on the Competence - Based Curriculum

Get the very latest techniques on how to pass Physics Practicals, for the New Lower Secondary Curriculum especially on

- The Very Latest Sure Deal Information
- Scenarios
- The Scientific Process
- The Theory of the experiment
- Measuring Instruments
- Data Presentation
- Graphing
- Calculations
- The new Marking Rubric
- Precautions in Physics Experiments
- Sure Deal Original Scenario Questions

LOWER SECONDARY CURRICULUM

Centenary A. Tumuhaise

- ➢ You can also draw axes of the graph which will help you to analyse the results.
- ➢ You can also think of the possible sources of error as the investigation is being done and their possible remedies or solutions in order to ensure accuracy of the final answer.
- ➢ You can also check the apparatus if it is working.

What to do in the last 1¼ hours?

You are now expected to perform the real scientific investigation and present your findings in form of a report. You must follow the guidelines of the Scientific process and Scientific experimental investigation.

Your report should have the following:

* The aim of the investigation.
* If you are going to draw your own diagram, list the apparatus you are going to use in the investigation. If you are going to use the diagram given in the item, there is no need to list down the apparatus.
* Scientific hypothesis.
* Variables.
* Procedure of the experiment.
* Presentation of data.
* Data analysis by using a graph.
* Data interpretation.
* Advise/conclusion as required in the task or scenario
* Risks/errors in the experiment.
* Means of mitigating errors.

1.30 Scenario-based questions

A scenario is an imagined or real situation.

A scenario-based question is the one which asks you about an imagined or real situation. Such a question requires you to think deeply rather than recalling learned material from your memory.

In the New Lower secondary curriculum, all the set questions will be scenario-based.

Characteristics/qualities of a good scenario-based question.

* It should be authentic, i.e., it should be genuine and shouldn't be over imagined.
* It should be drawn out of a problem in the society or environment. Therefore, the solution should solve this societal or environmental problem.
* It should be complex enough. A good scenario should neither be too simple nor to difficult. To come to its solution, the learner's mind should process the answer through a series of steps. One should not give a response/answer by just reading through the scenario once.
* It should have a relevant support material. This is a material provided to assist the taker to understand the scenario. The support material might be a photograph, data, diagram or bar graph but related to the scenario given.
* The language used should be precise and clear. Difficult words must be avoided when formulating a scenario.
* It should be original, that is, it should be created personally.
* It should evoke or bring about the expected responses. When one reads through a scenario, it should enable one's minds should develop answers or solutions.
* It should not favour categories of some takers. It should not be religion-biased, rural or urban-biased, tribe-biased, sex-biased, etc.
* It must be got from the scope of the curriculum.

The Scientific Process/Investigation/method

It is now mandatory that the items set will be scenarios that require a candidate to carry out a scientific investigation. A scientific investigation has an internationally accepted way of carrying it out. This internationally accepted way is called a **scientific process,**

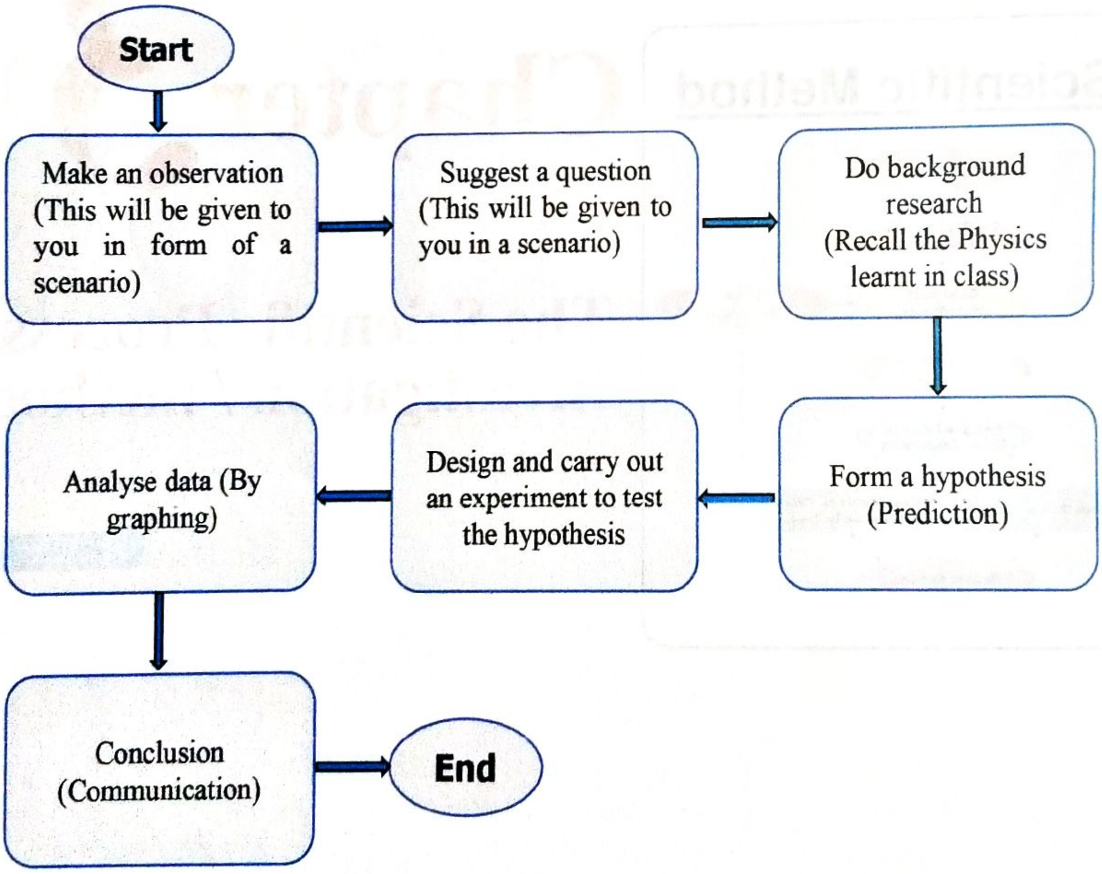
A scientific process is a general guideline which people use or follow in conducting investigations/experiments used to provide scientific explanations for questions about the world. It outlines the way a scientist can perform an investigation/experiment.

It is also defined as a process of establishing facts through testing and experimentation.

It can also be defined as the process of experimentation used to explore observations and answer questions.

3.10 Steps of a Scientific process

The exact steps of a scientific process may vary depending on the scientific question. However, there are 7 general steps involved in a scientific process. These steps are shown in the flow chart below.



3.11 Scientific Hypothesis

While carrying out an investigation, it is mandatory that you write down a hypothesis.
This is defined as:

* A testable clear statement about what you think will happen in a scientific experiment based on your observation and prior knowledge.
* A prediction of the outcome of the experiment.
* An idea or proposition that can be tested by observations or experiments about the natural world.

In lay man's language hypotheses are educated guesses.
In order to be considered scientific, hypotheses are subject to scientific evaluation.

At the end of the experiment, a hypothesis is either accepted for the time being waiting for new information or rejected as false.

Ways of stating a hypothesis

A hypothesis can be stated in **three** ways:

(a) **Cause and effect:** This predicts the outcome if a certain action is done or applied. Such a hypothesis is called a *causal hypothesis*.
Using this way, a hypothesis can be stated as: If ……, then …..

(b) **Correlation:** This way predicts a relationship between two variables.

(c) **Comparison:** This way predicts a difference in performance between two groups. A hypothesis stated in this way is called a comparative hypothesis.

Characteristics of a good hypothesis

- It should be testable, meaning it can be easily supported or refused at the end of the experiment.
- It should preferably be written using words If ……….. then ………………
- It should have both the independent and dependent variables.

Examples

* If you leave lights on, it takes long for people to fall asleep.
* If you refrigerate apples, they last longer before going bad.
* If you keep curtains closed, then the electricity bill is lower.
* If you leave a bucket of water uncovered, then it evaporates more quickly.
* If you increase temperature of particles, their kinetic energy increases.

3.20 Carrying out an Experiment and Writing a Report on the Experiment

When you carry out an experiment to test a hypothesis and then write a report on the experiment you have to follow the following steps:

1. State the aim of the experiment. An aim is the statement that shows a relationship between variables as stated in the hypothesis to be tested.
2. List the **manipulated**, **responding** and **fixed** variables.
3. List the **apparatus** and **materials** needed for the experiment
4. Draw a **scientific drawing** of the arrangement of the apparatus. This is done in case there's no diagram given in the item.
5. Write the **procedure** for carrying out the experiment in a proper order. The procedure should include the method of controlling the manipulated variable and the method of measuring the responding variable.
6. **Tabulate** the data obtained from carrying out the procedures.
7. Show **how the data can be analysed** to test whether it supports the hypothesis or not.

   Data can be analysed by plotting and analyzing a graph by calculations or by comparisons.

The flow chart below shows a summary of steps involved in designing and carrying out an experiment to test a hypothesis:

The results of an experiment may be analysed by plotting them on a graph.

By convention, the independent variable is usually used as the *x*-axis (horizontal axis) while the dependent variable as the *y*-axis (vertical axis).

The acronym **DRYMIX** can help you understand this.

D is the dependent variable and is also known as

R is the responding variable

Y is the axis on which the dependent or responding variable is graphed (the vertical axis)

M is the manipulated variable or the one that is changed in an experiment and is also known as

I is the independent variable.

X is the axis on which the independent or manipulated variable is graphed (the horizontal axis).

Please note that switching the variables may or may not make sense.

Example

A scientist measures how far an athlete moves within a given amount of time. Every second, he measures how far the athlete has gone and creates a graph for his results.

Identify the independent variable and dependent variables in this experiment.

Solution

Independent variable: Time

Dependent variable: Distance

As already seen, the independent variable is manipulated/changed by the experimenter. The dependent variable reacts to changes made in the independent variable.

In this particular task, the scientist is measuring how the athlete's distance changes over a given time. He is able to control the amount of time that he measures and is able to observe and measure the distance travelled.

In the graph therefore, time is graphed on the *x*-axis and distance on the *y*-axis.

3.23 Apparatus/tools of the experiment

Apparatus means technical equipment or appliances or things needed to carry out a scientific investigation or experiment.

When presenting a report of a scientific investigation, a list of apparatus used should be stated/outlined.

3.24 Scientific diagrams

You may be given a scenario with a diagram. The diagram enables you to arrange the apparatus and to proceed and do the investigation.

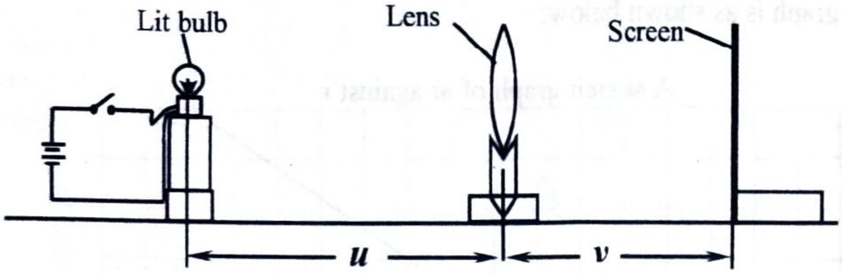
In case the diagram is not given, you must draw your own using a pencil or carefully using a pen.

It is also possible that the diagram is given but you chose to use a method that does not use the given diagram in the scenario. In this case, draw your own and then use it to assemble the apparatus.

By definition, a ***scientific diagram*** is a picture which shows exactly how the apparatus is assembled or set up during an experiment. Diagrams must be very clear, precise and easy to understand.

Scientific diagrams are used as part of the scientific method to exactly show how an experiment was set up and carried out so that other scientists can repeat the experiment. This is an important part of making sure that the experiment is reproducible.

Diagrams are usually drawn in a two-dimensional format.



From the lens formula

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

To introduce the idea of magnification, multiply each term by v.

$$\frac{v}{f} = \frac{v}{u} + \frac{v}{v}$$

But $\frac{v}{u} = m$

$\therefore \quad \frac{v}{f} = m + 1 \quad \Rightarrow \quad m = \frac{v}{f} - 1$

This is the same as, $m = \frac{1}{f}v - 1$

At this step, we think about which quantities in this expression can be changed and which ones can remain constant.

We realise that f is fixed; it cannot change since it is a constant physical property of the lens. We also realise that the magnification, ***m***, can change by changing ***u*** to get the corresponding value of ***v***. Then, m is obtained from $m = \frac{v}{u}$. This means that if we can change ***u***, resulting into a change in ***v***, magnification, ***m***, changes.

Hence, ***u*** becomes an independent variable (quantity), ***v*** becomes a dependent variable and ***m*** becomes a calculated variable. Focal length, ***f*** and amount of light become fixed variables.

Comparing $m = \frac{1}{f}v - 1$ with $y = mx + c$

m	=	$\frac{1}{f}$	v	-	1
y	=	m	x	+	c

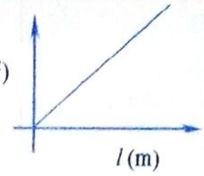
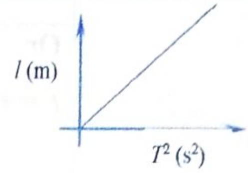
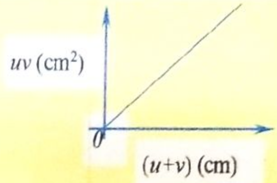
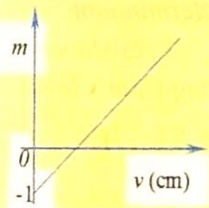
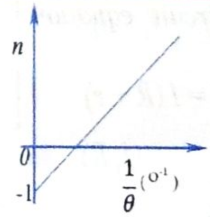
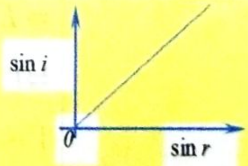
In the table of results, we should have values of u, v and $\frac{v}{u}$ in that order.

Therefore, a graph of ***m*** against ***v*** is a straight-line graph with a slope, $m = \frac{1}{f}$ and intercept on the vertical (y-) axis, $c = -1$.

From the above discussion, the solutions to the tasks are:

(i) An experiment to determine the focal length of a lens.

(ii) Independent variable is object distance, u.
Dependent variable is object distance, v.
Fixed variables are: focal length of the lens, quantity of light.

Determining acceleration due to gravity using a simple pendulum $T = 2\pi\sqrt{\frac{l}{g}}$ (T, l)	$T^2 = \frac{4\pi^2}{g} l$	T^2	l	$\frac{4\pi^2}{g}$	0	
	$l = \frac{g}{4\pi^2} T^2$	l	T^2	$\frac{g}{4\pi^2}$	0	
Determining focal length of a lens $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ (u, v)	$\frac{1}{f} = \frac{u+v}{uv}$ $uv = f(u+v)$	uv	$u+v$	f	0	
$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$	$-\frac{1}{u} = -\frac{1}{f} + \frac{1}{v}$ *Multiply by v throughout* $-\frac{v}{u} = -\frac{v}{f} + 1$ $\frac{v}{u} = \frac{v}{f} - 1$ $m = \frac{v}{f} - 1$ $m = \frac{1}{f}.v - 1$ (m, v)	m	v	$\frac{1}{f}$	-1	
For images formed in inclined plane mirrors $n = \frac{360}{\theta} - 1$	$n = (\frac{1}{\theta}.360) - 1$	n	$\frac{1}{\theta}$	360	-1	
Determining refractive index of material of a glass block or prism $\frac{\sin i}{\sin r} = n\ (i.r)$	$\sin i = n \sin r$	$\sin i$	$\sin r$	n	0	
$f = \frac{L^2 - d^2}{4L}$ (L, d)	$L^2 - d^2 = 4fL$	$L^2 - d^2$	L	$4f$	0	*Learner's Activity:* Draw a sketch graph for the information.

Investigations

12.10 Mechanics investigations

Investigation 1

Scenario

A mobile money operator working on a certain street in a trading centre had a problem when his umbrella was blown away by wind. He picked the remains of the umbrella but discovered that the spring was missing. He took the umbrella to be repaired but was told to buy a spring of force constant 50 N m^{-1} from a neighbouring hardware shop. On reaching there, he was given a spring but was not sure whether it was of the right force constant or not.

Among other pieces of apparatus, you are given such a spring that the man bought.

Task

Carry out a scientific investigation to ascertain whether the spring the man bought can be used for the umbrella to work properly or not and advise him accordingly

Hint

Hooke's law may be useful to you and states that extension of a material is directly proportional to the applied force provided the elastic limit of an elastic material is not exceeded. The formula $F = ke$ may be useful. Alternatively, you can use $T = 2\pi\sqrt{\frac{m}{k}}$