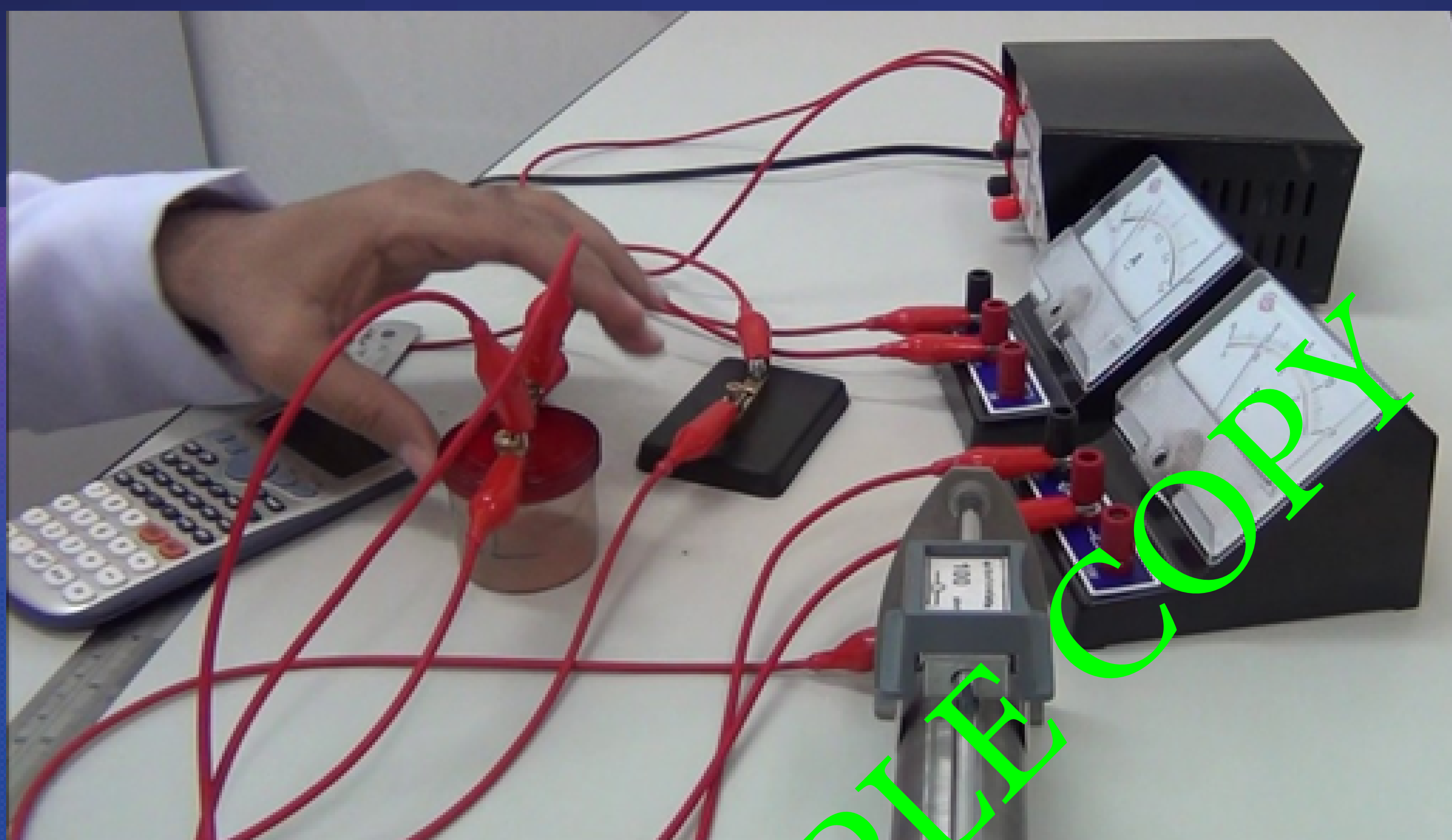

WAKATA PUBLISHERS

UCLSE NEW CURRICULUM PHYSICS PRACTICAL WORK BOOK

UCLSE
New Curriculum
Physics

Practical Workbook

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Practical Workbook

BY

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Introduction to New Curriculum Physics Practical

Practical skills form the backbone of any physics course. It is hoped that by using this book, you will gain confidence in this exciting and essential area of study. This book has been written to prepare Uganda Certificate of Lower Secondary Education (UCLSE) physics students for the practical paper.

For this practical paper, you need to be able to demonstrate a wide range of practical skills. Through the various investigations and accompanying questions you can build and refine your abilities so that you gain enthusiasm in tackling laboratory work. Aside from the necessary exam preparation, these interesting and enjoyable investigations are intended to kindle a passion for practical physics.

Great care has been taken to ensure that this book contains work that is safe and accessible for you to complete. Before attempting any of these activities, though make sure that you have read the safety section and are following the safety regulations of the place where you study.

Skills

Assessment Objective 3 (AO3) ‘Experimental and Investigative skills’ of the UCLSE is about your ability to work as a scientist. Each aspect of the AO3 has been broken and listed for you below.

- Demonstrate knowledge of how to safely use techniques.
- Demonstrate knowledge of how to use apparatus and materials.
- Demonstrate knowledge of how to follow a sequence of instructions where appropriate.
- Plan experiments and investigations.
- Make and record estimates.
- Interpret experimental observations and data.
- Evaluate methods.
- Suggest possible improvements to methods.
- Constructing own table.
- Drawing / analysing a graph.
- Planning safety of an investigation.
- Mathematical calculations.

Safety section

Despite the fact that Bunsen burners, electrical circuits and chemicals are used on a regular basis, the science laboratory is one of the safest classrooms in a school. This is due to emphasis on safety and the adherence to precautions and procedures resulting from regular risk assessment.

It is 'imperative' that you follow the safety rules set out by your teacher. Your teacher will know the names of materials, and the hazards associated with them, as part of their risk assessment for performing the investigations. They will share this information with you as part of their safety brief or demonstration of the investigations.

Here are some precautions that will help to ensure safety when carrying out most investigations in this workbook.

- Wear safety spectacles to protect your eyes.
- Tie back hair and any loose items of clothing.
- Tidy away personal belongings to avoid tripping over them.
- Wear gloves and protective clothing as described in the book or by your teacher.
- Turn the Bunsen burner to the cool, yellow flame when it is not in use.
- Keep all electrical circuits away from water.
- Observe hazard symbols and chemical information provided with all substances and solutions

Note: Many of the investigations require team work or group work. It is the responsibility of your group to make sure that you plan how to be safe as diligently as you plan the rest of the investigation.

Reliability, Accuracy and Precision

A common task in this book will require you to suggest how to change the method used in an investigation to improve its reliability, accuracy and precision. Before discussing how to make these improvements, it is important that you understand what each of these words means.

Reliability is refers to the likelihood of getting the same results if you did the investigation again and being sure that the results are not just down to chance. For this reason, reliability is now oft en called **repeatability**. If you can repeat an investigation several times and get the same result each time, your investigation is said to be reliable.
You can improve the reliability of your investigation by:
• controlling other variables well so they do not affect the results.
• repeating the experiment until no anomalous results are achieved.

Accuracy is a measure of how close the measured value is to the true value. The accuracy of any results depends on the measuring apparatus used and the skill of the person taking the measurements.
You can improve the accuracy of your results by:
• improving the design of an investigation to reduce errors
• using more precise apparatus
• repeating the measurement and calculating the mean

Precision relates to how accurately you take your measurements. Precise results have very little deviance from the mean.
You can improve the precision of your investigation by:
• using apparatus that has smaller scale divisions

Designing an investigation

When asked to design an investigation you must think carefully about what level of detail to include.
The following is an example of how to create a method. Follow these steps to design reliable, accurate investigations.

1. Identify your independent variables and state the range of values that you are planning to use for them.
2. Identify the dependent variable and explain how you are going to measure it. Describe the equipment and apparatus.
3. To ensure that the experiment you are conducting is reliable you will need to identify and control a number of variables that may impact your results. List these and explain how you will keep them constant.
4. Outline the method in a series of numbered steps that is detailed enough for someone else to follow.
5. Remember to include repeat readings to help improve reliability.
6. You must also include any hazards and safety warnings, as well as safety equipment that should be used in the investigation.

Practical investigation 1. Estimating measurements

Objective

You probably make estimates of time, distance and space on a daily basis, without realising it. Taking accurate measurements is crucial. A doctor must be accurate in measuring out a volume of medicine to treat a patient correctly. An engineer must measure the forces on a suspension bridge accurately to ensure the bridge will remain firm under a variety of conditions. In these examples, inaccurate measurements could be catastrophic.

In this investigation you will take accurate measurements of mass, weight, temperature, time and distance to compare them with your estimated values.

Equipment

- metre rule
- stopwatch
- thermometer
- top-pan balance
- spring balance (newton scale)
- micrometer screw gauge
- half metre rule

Method

(a) Look at everything you are going to measure (below). Estimate each value and record your estimates in the table that has been provided.

(b) Take measurements of:
- your friend's height (in cm)
- how long it takes a student to perform 10 star jumps
- the length, width and thickness of a glass block (measured with a micrometer screw gauge)
- the diameter of a piece of wire
- the temperature of a glass of ice water
- the mass of a bag of sugar
- the diameter of a steel ball bearing (using a micrometer screw gauge).

(c) Record your accurate measurements in the table.

Safety considerations

Before you start recording the time for star jumps, check that the surrounding area is clear of obstructions.

Check the floor for steel ball bearings in case anyone slips on them. Check with your teacher that your footwear is suitable for this task.

Recording data

(a) Record your measurements in the table. Remember to include the appropriate units.

Measurement being taken	Estimated value	Measured value

Analysis

(b) Are your estimated and measured values very different? Use the data in your table to compare your answers.

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(c) Calculate the volume of the glass block, based on the measurements you have taken.

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(d) Using a half metre rule, re-measure the glass block. Calculate its volume, based on these measurements. Is there a difference between your two values?

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Evaluation

(e) Suggest **one** reason why your volume measurements for the glass block might be different.

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(f) Were the measuring instruments that you chose, suitable in each case? If not, suggest what other instrument you could have used.

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(g) List **three** of the instruments you used and give the precision of these instruments. The precision of an instrument is the smallest scale division on the instrument.

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Practical investigation 2. Determining π

Objective

There are relationships between many variables in science. One such is the relationship between the circumference and the diameter of a circle. Engineers use this relationship to balance the blades on a helicopter, mechanics use it when fitting tyres and bakers might use it when baking circular pies.
In this investigation you will use two different measuring methods to determine the relationship between the diameter and circumference of a circle. You will use a graph to show the relationship between the two variables.
When you have plotted the points on your graph, you will need to draw a **line of best fit**. It should go through as many of the points as possible, with roughly equal numbers of points above and below it. For this investigation, the line of best fit will be a straight line that shows the trend of the plotted points.

Equipment

- 6 modelling clay balls of varying sizes
- string
- micrometer screw gauge
- ruler

Method

(a) Select a ball and measure its diameter, **d** across its centre, using the micrometer screw gauge. Take care not to squash the ball out of shape. Record your measurement in the table below.

(b) Repeat the measurement in two different places across the ball. Record the measurements in the table and find the average (mean) of all three.

(c) Loop a piece of string around the ball snugly. Mark the string where it overlaps, passing once around the ball.
Remove the string and use the 30 cm ruler to measure the distance between the marks on the string. Record the value in the table provided.

(d) Repeat steps (a)–(c) for five more balls.

Safety considerations

Take care when handling the modelling clay. To prevent slipping, ensure you do not leave any of the balls on the floor.

Recording data

(a) Record your measurements in the table including values of circumference, **c**.
NB: When recording your data in the table you do not need to include the units next to every reading, **provided that they are included in the table headings**. Make sure you record all values to the same number of decimal places.

Ball	$d(cm)$				$c(cm)$
	1	**2**	**3**	Average	
1					
2					
3					
4					
5					
6					

Handling data

(b) Plot a graph of your results on the graph below.

(c) Draw the line of best fit on your graph.

Analysis

(d) Now look at the line of best fit. Describe its appearance and state any key points through which it passes.

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(e) The circumference and diameter of a circle are directly proportional. On a graph, this is represented by a straight line through the origin. Does your graph support this relationship? Give reasons for your answer.

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(f) Calculate the gradient of your graph.

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(g) The equation for the circumference, C, of a circle is:
$C = \pi d$
where π is a constant of approximate value 3.14 and d represents the diameter of the circle.
Do your results agree with this equation?
Use the gradient/slope of your graph to help support your answer.

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Evaluation

(h) State another way in which you could have measured the circumference of the ball.

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(i) Which of these methods is more accurate? Give reasons for your answer.

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(j) Explain why you needed to take three measurements across each ball.

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(k) The gradient/slope of your line should be close to 3.14. Suggest **one** reason why your value might differ from this and from those of other students.

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(d) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

$G =$ ………………………………… *(01 mark)*

(e) Determine the mass , in grams, of the load **X**. Use the equation L $\frac{)}{\text{vr r}}$

L……………………………… C *(01 mark)*

Experiment 6

A student's plastic bottle of water tips over in class.
Plan an experiment to investigate how the quantity of water in a plastic bottle affects its stability.
The plastic bottle holds up to 2000 cm^3 of water and has a height of 42 cm.
Write a plan for the experiment, including

- the apparatus needed
- instructions for carrying out the experiment
- the values you will use for the quantity of water
- how you will make sure your results are as accurate as possible
- the graph you will plot from your results

A diagram is not required, but you may add to Figure. **6**, or draw your own diagram, if it helps to explain your plan.

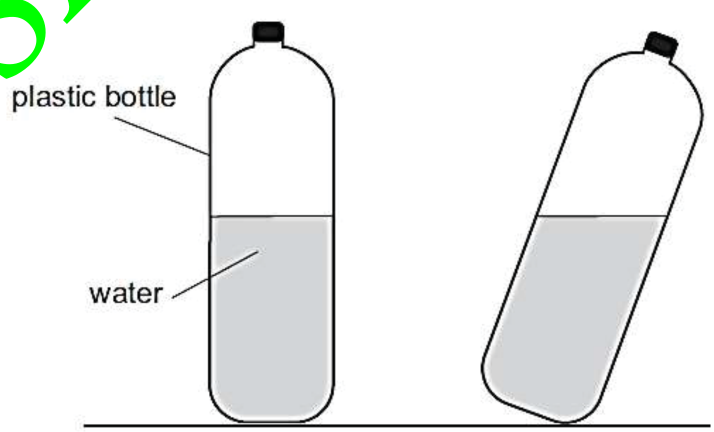

Fig. 6

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Experiment 50

A student attaches a propeller to an electric motor driven by a 0 to 12 V d.c. power supply as shown in Figure **50**.

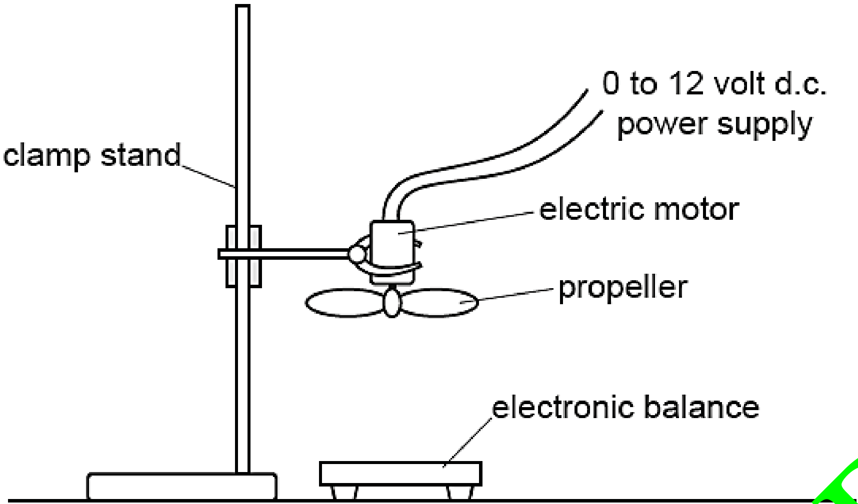

Fig. 50

Moving air from the propeller exerts a force on the balance.

Plan an experiment to investigate how this force varies with the voltage of the power supply.

The following apparatus is available:

an electric motor
an electronic balance
a power supply
a propeller
a voltmeter.

You can also use other apparatus and materials that are usually available in a school laboratory.

You are **not** required to do this investigation.

In your plan, you should:

- explain briefly how to carry out the investigation
- state the key variables to control
- draw a table, with column headings, to show how to display your readings (you are **not** required to enter any readings in the table)
- explain how to use your readings to reach a conclusion.

Experiment Requirements(Practical Instructions)

In addition to the apparatus ordinarily contained in Physics laboratory, each candidate will require:

EXPERIMENT 1

No apparatus is required for this question

EXPERIMENT 2

No apparatus is required for this question

EXPERIMENT 3

(i) Steel spring (see note 1).
(ii) Two clamps, two bosses and two stands.
(iii) Metre rule (see note 2).
(iv) Masses of 100 g, 200 g, 300 g, 400 g and 500 g, labelled 1 N, 2 N, 3 N, 4 N and 5 N (see note 4).

Notes

1. An expendable steel spring is suitable, for example a 55 mm long spring with diameter 15 mm. The spring must be able to take a load of at least 5 N without overstretching.
2. The metre rule is to be held vertically, using one of the clamps, with the zero end in contact with the bench.
3. The apparatus is to be set up for the candidates as shown in Fig. **3**. The spring is to be sufficiently high above the laboratory bench that when the 5 N load is hung on the spring, the bottom of the load is about 10 cm above the surface of the bench.

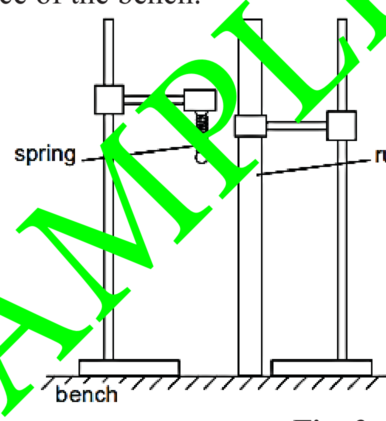

Fig. 3

4. A 100 g mass hanger with four 100 g slotted masses, each labelled 1 N, is ideal. If these are not available a suitable light hook must be provided so that the masses can be hung from the spring.

EXPERIMENT 4

(i) Expendable spring, approximately 20 mm coiled length × 15 mm diameter, capable of supporting at least 500 g without overstretching (e.g. Philip Harris expendable steel spring, B8G87194). See note **1**.
(ii) Metre rule.
(iii) A 300 g mass and a 500 g mass. See note **2**.
(iv) 2 clamps, 2 bosses and a stand. See notes **3** and **4**.
(v) A pin mounted in a cork. See note **3**.