NEW ORDINARY LEVEL PHYSICS PRACTICAL WORK BOOK

(HANDS-ON)

SENIOR ONE TO SENIOR FOUR

"USING LOCALLY AVAILABLE MATERIALS"

BASED ON THE NEW LOWER SECONDARY CURRICULUM

by

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1st Edition

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Preface

As the era of Alternative to Practical comes to an end, it is my hope that science teachers nationally embrace the new paradigm, that science lessons should be student-centred, competence-based, activity-oriented, and connect with student's life experience. Every learner in Uganda should perform practical exercises, not just the few that will be tested on national exams, but the wider range of hands-on activities teachers should employ to build a deep understanding in their students. Educational research has identified two obstacles to the universal implementation of hands-on science education. First, many teachers themselves learned in Alternative to Practical schools and therefore, lack essential experience with hands-on science. The remaining challenge is a fallacy rooted in ignorance and complacency: the idea that the materials required for hands-on science teaching are unavailable to most schools. I reject the notion that science education requires expensive, imported materials. Everything required to teach modern science is already available in our villages and towns. The challenge is simply to begin. Science belongs to Uganda as much as any country in the world. The law of gravity respects no national boundaries; we all feel its effect and can measure its strength. Those who decry the use of locally available materials as "stone age science" misunderstand the meaning of Science- that it applies universally, in any situation, with any material. Dependence on expensive imported materials teaches students that Science is a foreign concept, to be memorized rather than understood, and that Science lacks application to daily life. Science is the birthright of humanity, as much as Language or Mathematics or Music, and the time has come to embrace what we already own.

This learner's practical workbook has been written in line with the revised physics syllabus for the new lower secondary curriculum. It will equip teachers with the knowledge and skills to deliver hands-on science lessons in any school. I hope that this work book will also inspire school inspectors, examiners, curriculum developers and college tutors to increase their emphasis on the importance of hands-on education, and to reject material deficiencies as an excuse for any absence of practical work. In the same spirit, this work book seeks to expand the range of approaches to learning Physics and it is my hope that the many stakeholders in science education will embrace alternative methods that enable quality delivery of science education for every learner.This learner's workbook is one of the materials which are to be used to support the teaching and learning process of the new lower secondary curriculum.

I feel confident that this Book will be of immense value to both the learners and the teachers. Any suggestions for improvement of this book are most welcomed, thanks.

Background

Motivation for Writing this practical work book

I came up with this write-up basing on the abridged report on **" Evaluation of teaching-learning and Assessment of practical skills in the Physical Sciences at Uganda Certificate of Education"** by Uganda National Examinations Board Research and Innovations Department issued out by June 2023. The study covered all the 16 zones of Uganda, including Kampala city.

Quality science education requires students to perform experiments with their own hands. Unfortunately, research on the situation of secondary science education shows that many students do not perform such experiments. This is due to several factors, all of which can be addressed.

Specifically, this book demonstrates that many quality hands-on science experiments are possible with very basic materials. The experiments in these pages require materials available in villages or, at worst, in a regional capital. Standard laboratory materials certainly add value to science teaching; this book merely makes it clear that they are not required as a condition for provision of quality education.

Also a number of experiments are incorporated in this book to reinforce hands-on, many of them also include a "Notes" section to provide the teacher with additional information about the activity. This information may be practical or theoretical.

The vision as to why I have written this book is not for students to be spectators of science, but players themselves and also not for teachers to be passive implementors, but innovators themselves.

Any suggestions for improvement of this book are most welcomed, thanks.

- **Excel In Ordinary Level Mathematics(S.4 2023)**
- **S.1-S.2 Physics Project Work Book (1st Edition)**
- **S.1-S.4 Physics Project Work Book (2nd Edition)**
- **S.1-S.4 Mathematics Project Work Book (1st Edition)**
- **S.1-S.4 New Ordinary Level Physics Practical Work Book**
- **S.1-S.4 Physics Learners Research Book(Detailed)**

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Acknowledgement

I would like to express my sincere appreciation to all those who worked tirelessly towards the production of this learner's practical work book.
First and foremost, I would like to thank my family and friends for supporting all my initiatives both financially and spiritually, my parents; **Mr. William Lwanga** and **Mrs. Harriet Lwanga,** my brother; Mr. Nsubuga Grace.
My gratitude also goes to the various institutions which provided staff who natured and supported me to become the physics teacher I am today. My thanks goes to Broadway high school, Mita college kawempe and St. Lawrence College Paris Palais which provided the best environment to work from and best reference books.
I thank God for the wisdom He has given me to produce this volume of work. May the Almighty God bless all the teachers and students that will use this book with knowledge to encounter all physics hands-on experiments...….**AMEN**.
I welcome any suggestions for improvement to continue making my service delivery better.

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Chapter 1: Laboratory Equipment

Throughout this book you will see materials that have been marked with an asterisk (*). These are locally available materials which can be made or purchased for your laboratory. The guide for using and making these local materials are found in the following section.

Beakers

Use: To hold liquids

Materials: Water bottles, juice containers, lids for bottles or jars, and a knife

Procedure: Take empty plastic bottles of different sizes. Cut them in half. The base can be used as a beaker.

Delivery Tube

Use: For the movement and collection of gases, capillary tubes, hydraulic press

Materials: Straws, pen tubes, or pawpaw petioles.

Needles

Use: Compass needles, optical pins, making holes, flying wire

Materials: Office pins, sewing needles, needles from syringes

Droppers

Use: To add small amounts of liquid to something

Materials: 2 ml syringes

Procedure: Take a syringe. Remove the needle.

Funnel

Use: To guide liquid or powder into a small opening

Materials: Empty water bottles

Procedure: Take an empty water bottle and remove the cap. Cut them in half. The upper part of the bottle can be used as a funnel.

Heat Source

Use: Heating substances

Materials: Candles, kerosene stoves, charcoal burners or ethanol gel stoves

Procedure: Cut a metal can in half and add a small amount of ethanol gel

Stopper

Use: To cover the mouth of a bottle, hold a capillary tube

Materials: Rubber, cork, plastic water bottle cap.

Procedure: Cut a circular piece of rubber. If the stopper is being used to hold a capillary tube, a hole can be melted in a plastic cap or rubber stopper.

Water Bath

Use: To heat substances without using a direct flame

Materials: Heat source, water, and a cooking pot

Procedure: Bring water to a boil in a small aluminium pot, then place the test tubes in the water to heat the substance inside the test tube.

Circuit Components

Use: Building simple circuits, Ohm's Law, amplifier, wave rectifiers

Materials: Broken radio, computer, stereo, other electrical devices

Procedure: Remove resistors, capacitors, transistors, diodes, motors, wires, transformers, inductors, rheostats, pulleys, gears, battery holders, switches, speakers and other components from the devices.

Masses

Use: Calibrating and using beam balance and spring balance, Hooke's Law

Materials: Known masses, beam balance, sand, stones, plastic bags, thread, paper, tape, pen

Procedure: Use a beam balance and known masses to measure exact masses of sand or stones. Use a marker pen to mark the masses on the stones. If using sand, place a small piece of plastic bag on the scale pan and fill it with sand until you have the required mass. Tie the sand in the plastic bag with thread. Use paper and tape to make a label on the outside, marking the mass with pen. These masses can be used in your school. Water can also be as a known mass. The density of water is 1.0 g/ml, so you can use a known volume of water in a bottle to create a known mass. Be sure to also account for the mass of the bottle.

Plane Mirror

Use: Laws of Reflection, periscope, water prism

Materials: piece of thin glass, oil lamp with a wick, Optional: small pieces of mirror glass are cheap or free at a glass cutter's shop

Procedure: Light the oil lamp so that it creates a lot of smoke. Pass one side of the glass repeatedly over the oil lamp until that side is totally black. The other side acts as a mirror.

Iron Filings

Use: To map magnetic fields

Materials: Steel wool / Iron wool used for cleaning pots

Procedure: Rub some steel wool between your thumb and fingers. The small pieces that fall are iron filings. Collect them in a matchbox or other container to use again.

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Checking Voltmeters and Ammeters/Galvanometers

Needed: Meters to check, a couple of wires, some resistors and a fresh battery.

Important note: There is a wrong way to hook up the meter. The needle will try to detect down because negative and positive are swapped. If the reading is zero, make sure that you try the opposite connection to be sure.

Voltmeters

Hook up the voltmeter across the battery. The battery is probably 1.5 V, but do not worry if you see 1.1, 1.2, even if using a brand new battery. Try not to use a battery that reads much below 1 V on several different meters.

Unusable Voltmeters

- Totally dead, no detection of the needle
- Voltage reading jumps excessively. Ensure that the connections are solid and test again.
- Measured voltage is totally wrong, not close to 1.5 V

Usable Voltmeters

- Read a voltage close to 1.5
- If the voltage if not 1.5 exactly, the voltmeter is probably working and the battery is just old a bit.

Ammeters

Hook up the ammeter in series with a resistor. Because you do not necessarily know the condition of the ammeter before testing, be sure to have several different resistors on hand. An ammeter may appear not to work if resistance is too high or too low. Start testing different ammeters.

Unusable Ammeters

- Totally dead, no detection of the needle
- Current reading jumps excessively (but check connections)
- Totally wrong, reads much different from other ammeters

Usable Ammeters

Reads a current similar to other ammeters.

Hard to say exactly what current, but feel free to calculate based on your resistor using $V=IR$, although do not forget that there is some internal resistance "r" of battery, so $V = I(R + r)$.

The resistance of the resistor is usually coded on the resistor in a series in stripes - see the instructions under Resistors in the Sources of Equipment section.

Tip: You can hold the wires onto the battery with your fingers; the current is far too low to cause a shock.

Other: Now that you have tested to see if your voltmeters and ammeters work, you can feel free to check all of them for accuracy, by calculating expected values and comparing between meters. Most practicals will still work alright with somewhat accurate meters.

Chapter 2 : Physics Experiments Part I

Measurement