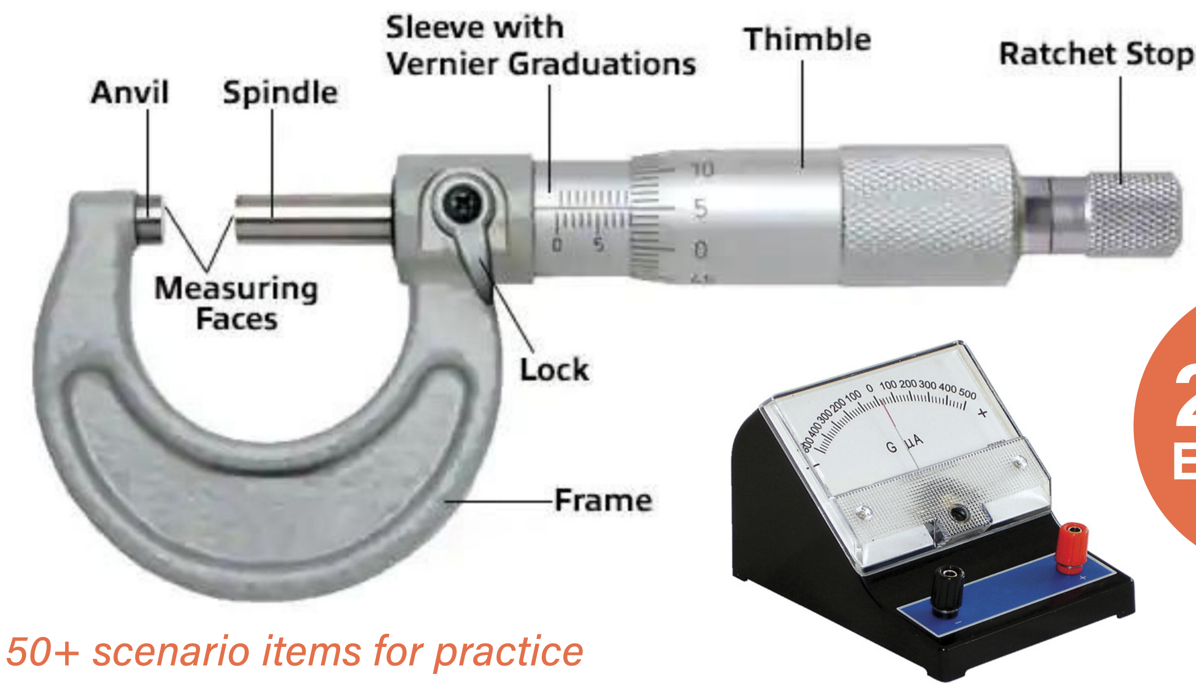
# MASTERING ADVANCED PHYSICS PRACTICALS

*A Scenario-Based Guide for UACE Success*

***KEY SKILLS:***

*Measurement, Data recording and presentation,*
*Data interpretation, Graphical skills and Report writting .*




**2026 EDITION**

*50+ scenario items for practice*

NAME: ..............................................................................................

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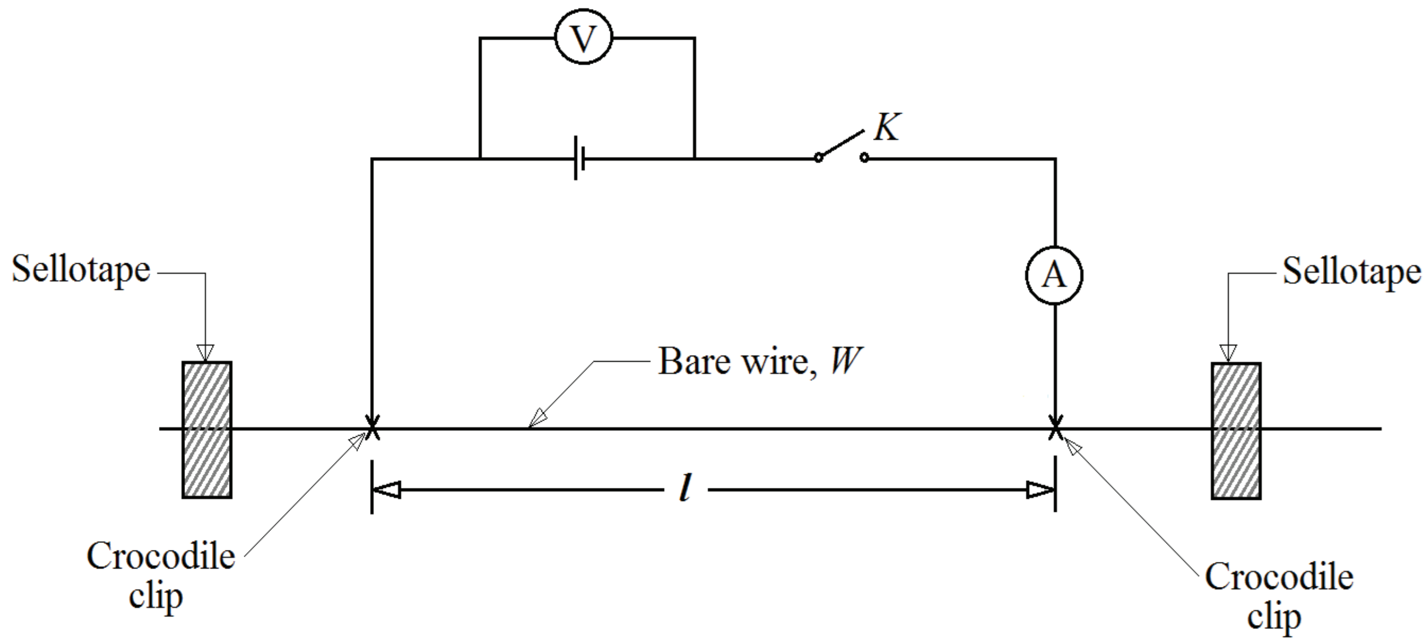


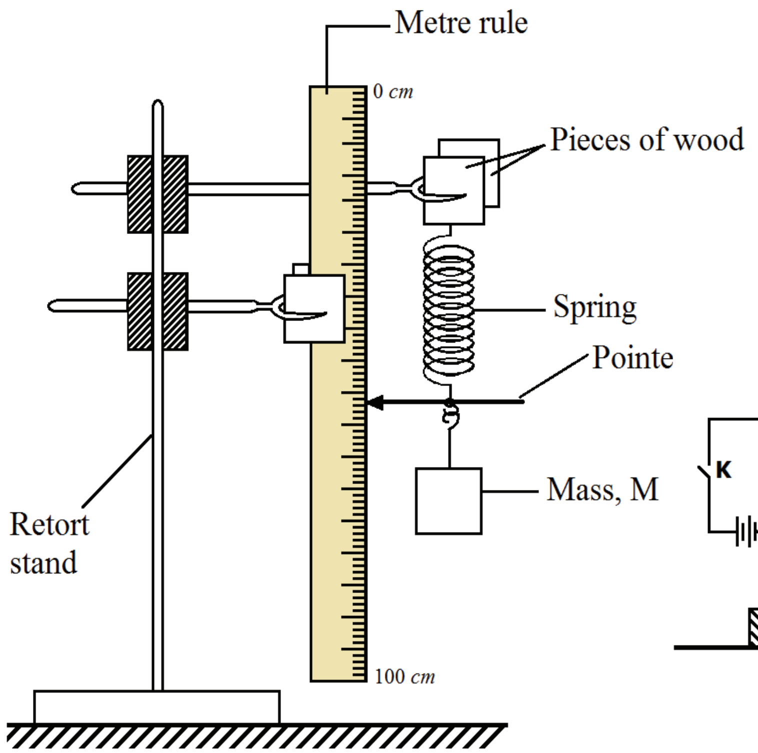


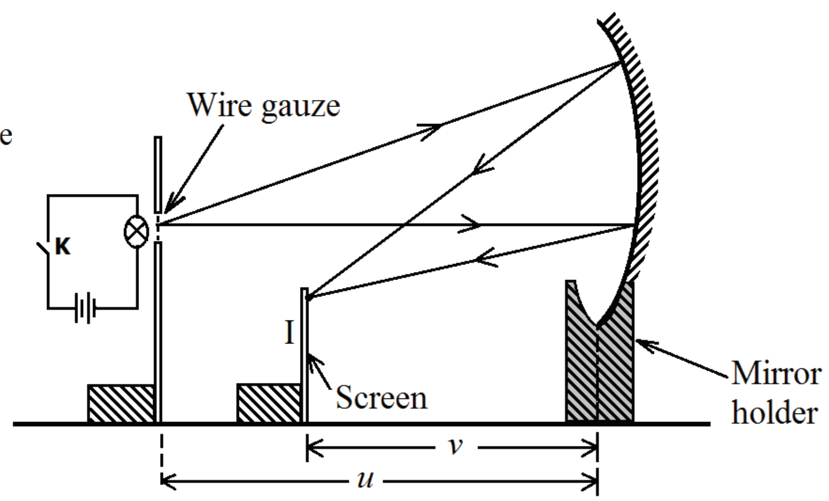



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## A Scenario-Based Guide for UACE Success

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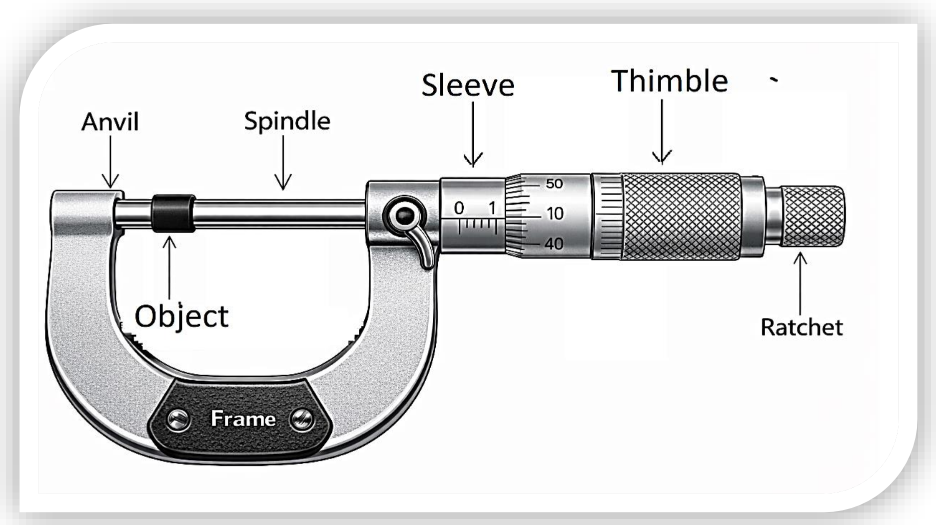


**NAME:………………………………………….Year……………… class …………**

**Frist edition**
**2026**

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# CHAPTER 1: INTRODUCTION

## 1.1 Physics Practical and its role

Physics Practical involves learning physics through observation, measurement, experimentation, and analysis. It allows learners to test ideas, verify physical laws, and understand how theoretical concepts apply to real situations. Through practical work, learners develop scientific thinking and gain confidence in handling apparatus and interpreting results.

## 1.2 Importance of Physics Practical.

Physics Practical is a vital part of learning physics as a subject. It offers you a chance to do hands – on activities that help you understand the concepts you learn in class. By conducting experiments, you can see how the principles and laws of physics work in real-life, making the subject very engaging and interesting for better understanding of its concepts.

The overall objectives of the physics practical are to help the learners learn

- to experiment i.e. measure unknown quantities and draw conclusions from results.
- to write scientific reports and
- to use specialized methods of experimental measurements.

## 1.3 Safety and responsible laboratory behaviour.

Safety is a key requirement in all practical work. Learners must follow laboratory rules, handle apparatus carefully, and use instruments correctly. Unsafe behaviour can lead to accidents damage to equipment, and unreliable results. Learners are expected to work responsibly, follow instructions given by the teacher, and report any accidents or damaged equipment immediately.

## 1.4 How to use this practical book

This practical book is designed to guide learners step by step in developing practical skills.

Learners should first study the sections on practical abilities, measuring instruments, and data handling before attempting experiments. Worked examples should be used as models for good practice, while the practice practical items should be attempted independently. Learners are encouraged to question their results, identify possible errors, and improve their methods. Consistent use of this book will help you develop confidence, accuracy, and independence in advanced Physics Practical.

# CHAPTER 2: PHYSICS PRACTICAL ABILITIES.

Practical abilities are part and parcel of teaching and learning of Physics. According to the advanced physics competence-based curriculum, a learner requires the following competencies to be able to handle the advanced physics practical:

a) Planning to select techniques, apparatus and materials
b) Identifying variables and controlling them
c) Making predictions based on prior knowledge and hypotheses
d) Manipulation of the apparatus and performing experiments.
e) Making and recording observations and measurements to the right accuracy of instruments and calculation.
f) Presentation of data in an appropriate form, such as graphical and any other appropriate
g) Manipulating graphical data by determining gradients, intercepts or any other required points and identifying patterns in outcomes
h) Drawing conclusions from observations made.
i) Assessing the suitability of procedure by identifying errors, limitations of measurements and /or experimental procedures used and suggesting methods of minimising the errors for better results.
j) Devising projects in which the products employ Physics principles

## 2.1 Planning to select techniques, apparatus and materials

Planning means that before any experiment begins, a good physicist must think carefully about what to measure, how to measure it and which instruments or materials will give the most reliable results. This ability is about designing an investigation intelligently. It involves:

- understanding the aim of the experiment.
- Identifying the variables to be measured and controlled.
- Selecting appropriate apparatus/ materials based on precision and suitability.
- Choosing the right measurement techniques.
- Planning to reduce errors and maintain safety.

A learner who masters this ability can:

- state the aim and purpose of the experiment clearly.
- Identify the variables that must be measured or controlled
- select appropriate techniques, apparatus to achieve the aim.
- Plan for accuracy, reliability (stating the possible sources of errors and how to minimize them) and safety before performing the experiment.

- Results of testing
- Conclusion and suggested improvements.

For example;

- Design and construction of a simple electric water level indicator.

A good physics project is not about expensive materials. It is about clear thinking, correct principles and purposeful design. Learners are therefore encouraged to be innovative while remaining accurate.

## 2.11 Guide to the teacher about practical abilities.

The practical abilities outlined in this book are drawn directly from progressively through regular laboratory work guided practice and project-based learning.

Teachers are advised to treat those practical abilities not as isolated skills, but as integrated competencies that should be reinforced in every practical lesson.

Approach to teaching practical abilities

Teachers are encouraged to;

- Introduce practical abilities explicitly not implicitly.
- Demonstrate expected skill before independent learner practice.
- Use guided practical work at early stages and gradually reduce support.
- Encourage learners to reflect on their performance after each practical session.

## 2.12 Guide to the teacher about Project Work.

For project-based activities, teachers should:

- Guide learners in selecting manageable and physics- based projects.
- Ensure that physics principles are clearly identified and applied.
- Monitor progress at different stages rather than only at final Submission
- Emphasize understanding and functionality over aesthetic appearances of products.

**Note**

While this book provides structural guidance, teaches are encouraged to:

- ✓ Adopt activities to available resources
- ✓ use professional judgment when assessing learner performance.
- ✓ Encourage innovation while maintaining scientific accuracy
- ✓ Consistence in standard should not eliminate creativity. Let the learners be.

# CHAPTER 3: MEASUREMENTS AND INSTRUMENTS

To be a successful experimenter, you should work in a highly disciplined way. The instrument used in the experiment should be treated properly, since the quality of the data you will obtain will depend on the condition of the equipment used. Mistreating the instrument may have a negative effect on the result of the experiment.

***Measurement*** is a process in which one tries to determine the amount of a specific quantity in terms of a pre-calibrated unit amount. This comparison is made with the help of an instrument. In measurement process only the interval where the real value exists can be determined. Smaller interval means better precision of the instrument. The least count value determines the degree of accuracy of the instrument.

You should have a very good knowledge of the instruments you will be using during measurements to achieve the best possible results from your work.

In this section we will explain how to use some of the common instruments you will be using during practical sessions.

## 3.1 Measuring length using a metre rule.

The simplest scale is the metre rule where you can measure lengths to a millimeter.

The precision of a meter rule is usually the smallest of its divisions (least count value)

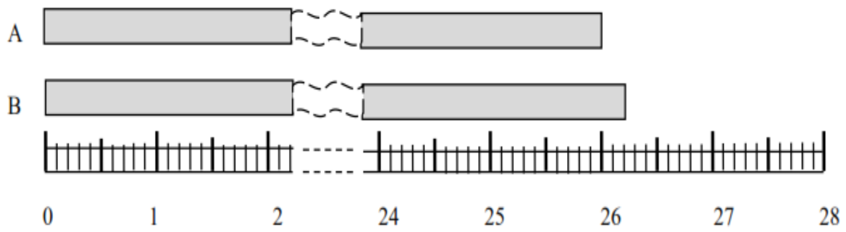


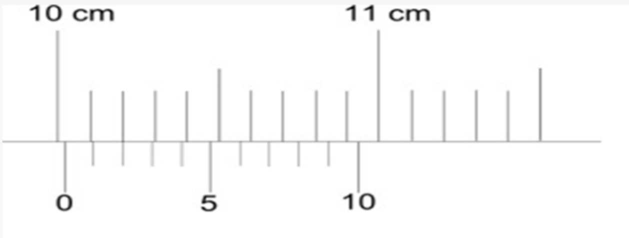

***Fig :1 : Length measurement by a meter rule.***

In **figure 1**, the lengths of object A and B are observed to be around 26 cm. since we use a metre rule with millimeter division the measurement result for the object A should be given as 26.0 cm and B as 26.2 cm.

When measuring length, place the edge of the rule along the straight line covering the length to be measured with a starting mark or point.

When taking readings from the rule the eye must always be placed vertically above the mark to be read as shown in **figure 2.** This is to avoid errors due to parallax error.

EXAMPLE 1



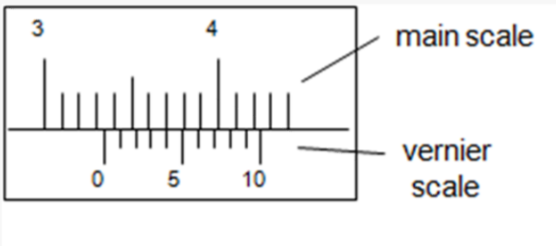

Look at the zero mark on the Vernier scale, look for the mark on the main scale which is just before the zero mark on the Vernier scale. This gives the approximate reading. In figure above, the reading is 10.00cm

Then look for the point on the Vernier scale where one of its marks on it coincides with one on the main scale and take readings. In figure above, this is 0.02cm (one division on the Vernier = 0.01cm, from our scale the mark is the $2^{nd}$ division and therefore multiplied by 0.01 the value becomes 0.02 cm)

Add the readings on the Vernier scale and that of the main scale.

The Measurement = 10.02cm.

***Example 2***




Main scale reading = 3.30cm

Vernier scale reading = 4x0.01

= 0.04 cm

Measurement reading is 3.30cm plus 0.04cm = 3.34cm

***Activity: 1.1 Understanding how to measure using analog vernier calipers.***

**What to do**

a) Get your workbook (this very one) and close it.
b) Get an analog vernier caliper and use it to measure the thickness of the book
c) Compare your results with your neighbour and then share with the class at large.

# 3.3 Measuring very small lengths using Micrometer screw gauge

The micrometer screw gauge is used for measuring the diameter of the wire, thread, ball bearing or marble, thickness of a metre rule and similar small distances. It measures in millimetre (mm) to two decimal places.

Before you carry out any measurement, you should check whether the zero mark on the sleeve coincides with the zero mark on the thimble when the jaws are closed.

If the two marks don't coincide you should seek help from the teacher.

Just like vernier calipers, we have an analog and digital micrometer screw gauge.

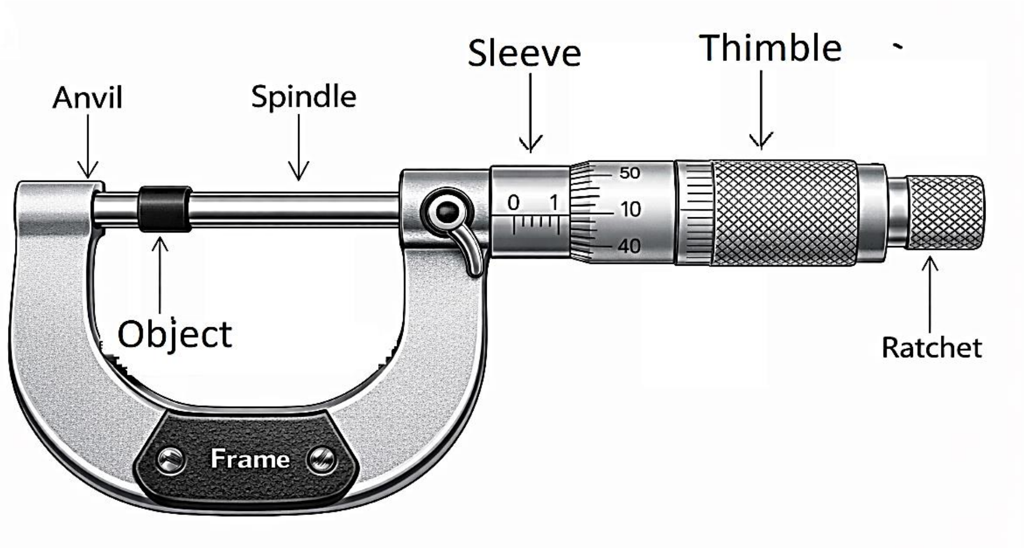



***Fig :5 : Analog micrometer screw gauge.***

The object whose diameter or thickness is required is held between the anvil and spindle as shown in **figure 5** above.

The thimble is turned until the object is about to be gripped and then the ratchet is now turned until it makes a cracking sound.

The reading can now be taken from the sleeve and thimble

# CHAPTER 4: DATA RECORDING.

When you carry out a measurement, you have to record the value obtained accurately with the correct unit. This is possible for the physical quantities that can be measured using instruments. For the quantities whose data is not measured, its obtained by manipulation of data from measuring instruments and their accuracy must be considered as well. Therefore, we have two types of data and these are; recorded data and manipulated data.

For the recorded data we have single measurements and repeated measurements

## 4.1 Single measurements

Single measurements are measurements whose procedure is not repeated e.g., measurement of the diameter of a wire, thickness of wood or glass block, breadth(width) of wood or glass block, length of a piece of thread or wire etc. The common instruments used for taking measurements are micrometer screw gauge, and vernier calipers; other instruments can also be used.

Single measurements should be carried out three times, at different points of the object under test for purposes of reducing the error in the measurement. The measurements should be recorded according to the unit and the precision of the instrument being used.

Figure 18 shows the measurement of diameter d of wire using micrometer screw gauge.


***Fig :18 : Measuring of the object at different points***

Measure the diameter of the wire at points A, B and C.

Suppose the measurements obtained are 0.34 mm, 0.34 mm and 0.35 mm, respectively. The measurements should be recorded in a simple table as shown below:

| $d_1(mm)$ | $d_2(mm)$ | $d_3(mm)$ |
|---|---|---|
| 0.34 | 0.34 | 0.35 |

Average of d $= \frac{d_1+d_2+d_3}{3} = \frac{0.34+.034+0.35}{3} = 0.34\ mm$

**Example 1**

Express 2.786 to two decimal places

$$2.786 \approx 2.79\ (2dp)$$

If the next digit is exactly five (5) and there are digits on the right-hand side of five (5) then the number is beyond half way and 1 is added to the digit in the number of decimal places required

**Example 2**

Express 1.72501 to two decimal places

$$1.72501 \approx 1.73\ (2dp)$$

If the next digit is exactly five (5) and there is no digit on the right-hand side of the five (5), then the number is just half way and one is not added to the digit to the number of decimal places required.

**Example 3**

Express 0.235 to two decimal places

$$0.235 \approx 0.23\ \ (2dp)$$

### 4.4.2 Manipulation of data in the table of results

When manipulating data in the table of results, there is a need to recall the rules for adding and subtracting numbers, multiplying and dividing numbers and approximations. When multiplying or dividing numbers, significant figures are used to determine the number of decimal places in a column.

The following examples have been carefully selected to guide the student on how to manipulate data.

$\boldsymbol{y = 0.950m}$

| $x(m)$ | d$(m)$ | $\frac{x}{y}$ |
|---|---|---|
| 0.100 | 0.002 | 0.015 |
| 0.200 | 0.004 | 0.211 |
| 0.300 | 0.006 | 0.316 |
| 0.400 | 0.008 | 0.421 |
| 0.500 | 0.011 | 0.526 |

A suitable scale is that which can be used to plot all the values needed and covers more than three quarters of the graph paper on both axes.

A convenient scale is that which can ease plotting of the points i.e user friendly to the student or scorer.

It should be a multiple factor of 1, 2, 2.5 or 5units for 10 small divisions (2cm) on the graph paper.

The factors can be;

| | | | |
|---|---|---|---|
| 1000 | 2000 | 2500 | 5000 |
| 100 | 200 | 250 | 500 |
| 10 | 20 | 25 | 50 |
| 1 | 2 | 2.5 | 5 |
| 0.1 | 0.2 | 0.25 | 0.5 |
| 0.01 | 0.02 | 0.025 | 0.05 |
| 0.001 | 0.002 | 0.0025 | 0.005 etc |

Always avoid scales which are such that; 10 divisions represent 0.333, 0.468, 10.37, 0.06589, 0.116 etc.

***Steps to follow when finding suitable and convenient scale.***

Get the range by getting the difference between the maximum value and minimum value to be plotted on any axis.

Divide the range by 10 to get the vertical scale and by 8 on the horizontal axis (For UNEB graph paper)

***Check on the convenient factor range.***

If it falls exactly on any value, use that as your interval (i.e., What 10 divisions represent) if not, get the interval by rounding it off to the nearest upper convenient factor.

For points that make a curve, use a pen for drawing the best curve. The curve must be a smooth one (not having corners).

## 5.3 Slope or gradient

The slope of the graph is the ratio of the change in the values of the vertical axis to the change in the values of the horizontal axis i.e.,

Slope, S = $\frac{change\ in\ vertical\ axis\ values}{change\ in\ horizontal\ axis\ values}$.

### 5.1.3 To find the slope follow the steps below.

Draw a large right-angled triangle. The slope triangle must cover all the plotted points.

It must not pass through the plotted points and should touch the line of best fit..

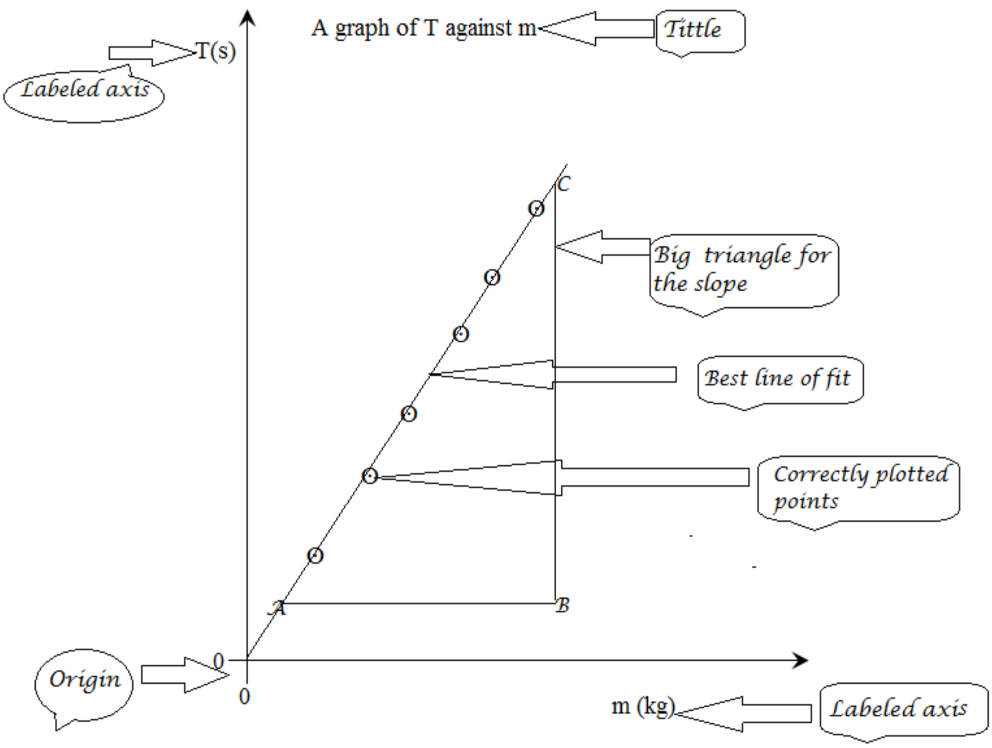
The values used to calculate the slope should be correctly read from the graph to the number of decimal places of the smallest division on that axis.

The units of the slope are determined by the units of the axes.

Substitute the slope value correctly into the final expression if any.

Calculate accurately the final expression and write its units correctly if any.

The graph below gives a summary of points about the features of the graph.




Slope = $\frac{change \in T(s)}{change \in m\ (kg)}$

# 5.4 Examples on graph work.

## 5.1.4 Example 1

| $x^2(m^2)$ | $T^2(s^2)$ |
|---|---|
| 0.01 | 0.53 |
| 0.02 | 0.56 |
| 0.04 | 0.64 |
| 0.06 | 0.72 |
| 0.09 | 0.86 |
| 0.12 | 1.00 |

a) Plot a graph of $T^2$ against $x^2$
b) Determine the intercept c on the $T^2$-$axis$
c) Find the slope s of the graph.

**Solution:**

Horizontal scale: $\frac{HV\text{-}LV}{8}$ where; HV = Highest value, LV = Lowest value

In this case LV = 0. Since the intercept is required on the $T^2$-$axis$

Thus, horizontal scale $= \frac{0.12\text{-}0}{8} = 0.015 \approx 0.02$

1 small square represents $\frac{0.02}{10} = 0.002$

Vertical scale: $\frac{HV\text{-}LV}{10}$

$= \frac{1.00\text{-}0.53}{10} = 0.047 \approx 0.05$

1 small square represents $\frac{0.05}{10} = 0.005$

The origin of the vertical axis should be below 0.53 so that the triangle for the slope does not touch the plotted point.

**Note:**

To plot a point, subtract the nearest less value on the axis from it, then divide by the scale of the axis. This gives the number of small squares which are counted from the nearest value that was subtracted.

If the value in the table is the same as in order of accurately plotted points, get the value (without rounding off) in the table of results to be plotted either on the horizontal axis or vertical axis. Then there is no need of using the above method.

The number of significant figures of intercept should be equal to the number of significant figures of the large value in the column of the table of results which is being plotted. Intercept on the $T^2$- axis, C = 0.470$s^2$ (the intercept on $T^2$-$axis$ should be to 3dp as the smallest square).

$Approximate\ slope, S = \frac{(1.025-0.505)(s^2)}{(0.130-0.008)(m^2)} = \frac{0.52}{0.122} s^2m^{-2} = 4.3s^2m^{-2}$

**Note**

Make sure you draw the graph on the graph below and compare your answer with the above answer. This will help you master the skill.

# CHAPTER 7: LAB REPORT FORMAT.

A ***laboratory report*** is a systematic written account of an experiment. Its purpose is to share that the student understands what was investigated, how it was investigated, what was observed and what the observations means. In A 'level physics practical a laboratory report is not a story of events but a logical scientific argument supported by data.

Each laboratory reports must follow a standard format. This format ensures clarity, accuracy and uniform assessment during continuous assessment, school examinations and UNEB practical examinations.

## 7.1 Aim of the experiments

The aim state clearly and facilities is what makes what experiment is intended to determine the investigators. Even in the purpose of carrying out the experience must be included in the aim. To build your Aim, you need to have understood both the scenario and the task.

**For example;**

"*A scientific investigation to determine the resistivity of a wire so that it can be used to prepare the radio*"

## 7.2 Theory of the experiment.

This explains the science behind what you are doing. It shows that you really know the experiment you're carrying out.

A good theory tells the examiner:

- What type of graph to expect
- What the gradient or slope represents
- What conclusion is scientifically acceptable

## 7.3 Variables

Every experiment involves variables. These must be identified and stated correctly.

**Independent variable; the** quantity that is deliberately changed during the experiment.

**Dependent variable;** in the quantity that is measured or observed as a result of changing the independent variable

**Controlling variables;** quantities that are kept constant to ensure fair test.

### 7.1.5 Standard flow of writing the procedure in practical.

- Start with arrangement of the apparatus that is to say your first step should be "*The apparatus were arranged as shown in the figure above*" however this depends on the method you're using.
- Then adjust the independent variable for the first set of data and the measure the dependent variable. That is to say "*The object was adjusted to a distance* $\boldsymbol{u} = \boldsymbol{70.0\ cm}$ *and screen moved to and fro until a sharp image of the wire gauze was formed on the screen. The distance v of the image from the lens was measured and recorded*"
- The next step should be repeating the experiment for very many sets of data. But for purposes of physics practical you're recommended to end at the sixth trial since these are enough to plot a graph. That is to say "*The step (s) in a range were repeated to obtain other values of v*".
- The next step is to record the data in an organised table of results (check 1.12). don't forget to include the calculated variables. That is to say "*The results were tabulated in a suitable table including values of* $\boldsymbol{uv}$ *and* $(\boldsymbol{u} + \boldsymbol{v})$"
- The next step should be the one for analyzing data using graph. That is say "*A graph of* $\boldsymbol{uv}$ *against* $(\boldsymbol{u} + \boldsymbol{v})$ *was plotted*"
- The last step should be the one for getting the unknown constant under investigation. That is to say "*The slope of the graph was got and this was equal to the focal length*". But for you be accurate here need a great knowledge of the theory of the experiment.

> **Note**
>
> The steps given above are standard and work on any experiment but you may just need to adjust a few things to suit your method.

## 7.6 Sources of errors and precautions

Sources of errors are factors that cause the experimental results to differ from the true or expected values. Identifying those shows awareness of experimental limitations.

Errors should be stated clearly and realistically. You should explain them.

Precautions are the specific steps taken to reduce errors and improve the accuracy and reliability of results.

Precautions should;

- be directed to the experiment
- be practical and realistic
- clearly address the identified sources of errors
- Each precaution should ideally correspond to one or more sources of error.

## 7.7 Data presentation

Data presentation shows us what was observed or measured during the experiment it must be neat organized and accurate.

This includes;

- Each column must have a heading and correct unit
- Repeated measurements should be clearly shown
- Both single measurements and repeated measurements must be presented properly.

## 7.8 Data analysis and interpretation

This section explains what the data means.

It may include;

- Calculations
- Drawing graphs
- Determining gradients (slopes)
- Finding intercepts
- Identifying relationships between variables the interpretation should link measured results to practical theory.

## 7.9 Conclusion and advice

The conclusion is a direct answer to the aim of the experiment.

It should;

- be short and precise
- refer to the results obtained
- state whether the hypothesis is supported or not
- No new information must be introduced in the conclusion.
- The advice is given based on the results given and the purpose of the experiment.

## 7.10 Summary of the laboratory report format.

1) Aim
2) Variables
3) Hypothesis
4) Procedure

- **Method I**
    - experimental design
    - experimental steps.

- **Method II**
    - experimental design
    - experimental steps.

5) Sources of errors and precautions
6) Data presentation
7) Data analysis and interpretation
8) Conclusion and advice

**Note;**

- The variables, the results of measurements and errors are supposed to be presented in tables. Therefore, the entire report should have a maximum of three tables.
- The steps should be written using past tense and the purpose of the apparatus should be included in the steps.

# CHAPTER 8: EXAMINABLE PRACTICAL AREAS

In this section we look at the physics experiments which are examinable at Advanced level and good for preparing you for UNEB assessments.

The experiments suggested in this book are not the final list so I encourage you to do research to get more experiments to make yourself super ready for UNEB. The table below summaries the experiments which are later discussed in details so that you can link them to what you learnt theoretically in normal classroom.

> **Note**
> The investigations are given according to the major topics that form all the topics that make up the syllabus of Advanced level physics but the items in the paper will come from any of the topics taught in A 'level which is practical.

| SECTION | EXPERIMENT |
|---|---|
| Mechanics | • Investigating acceleration due to gravity.<br>• Investigating the spring constant of a spring.<br>• Determination of the coefficient of friction between two surfaces<br>• Determination of young's modulus of a metre rule<br>• Investigating moment of inertia of a metre rule (rotational motion about an axis.<br>• Determination of the unknown mass of an object.<br>• Determination of relative density of a solid<br>• Determination of relative density of a liquid<br>• Determination of mass a metre rule. |
| Light | • Determination of focal length of a converging lens.<br>• Determination of the focal length of a concave mirror.<br>• Investigating refractive index of a prism.<br>• Investigating refractive index of a glass block.<br>• Determination of critical angle of a glass block<br>• Determination of radius of curvature of a concave mirror.<br>• Determination of the power of a lens.<br>• Determination of the focal lens that is inaccessible (displacement method)<br>• Determination of the thickness of a glass block. |

| | |
|---|---|
| Electricity | • Determination of the resistance of a wire using a meter bridge (Wheatstone bridge method)<br>• Determination of resistance of the wire or resistor using a voltmeter and ammeter. (ohm's law)<br>• Determination of internal resistance of a cell using a voltmeter and an ammeter.<br>• Determination of the emf and internal resistance of a cell using a potentiometer.<br>• Determination of resistivity of a material of a while.<br>• Determination of power and energy consumed in a resistive circuit.<br>• Determination of internal resistance of a cell using a voltmeter and an ammeter.<br>• Determining the accuracy of a voltmeter.<br>• Determining the accuracy of an ammeter. |
| Waves | • Determination of the speed of sound in air using a resonance tube method. |
| Heat | • Determination of the specific heat capacity of solids and liquids. |

# 8.1 Theories, variables, experimental diagrams and apparatus of the common examinable experiments

For you to be able to establish the correct procedure, correct variables, correct experimental diagrams, and aim of the investigation, you must have prior knowledge of the experiment that is, principle and theory behind that very experiment you are to carry out. In this section, we take you through some of the theories and principles of the common experiments. But it should be noted that they are not the final, here we give you samples and then you build from them to also look for yours after mastering the format.

## 8.1.1 Determination of acceleration due to gravity using a simple pendulum.

***Principle and theory behind this experiment*.**

A simple pendulum consists of a small dense mass (called a bob) suspended from a fixed point by a light inextensible string. When the bob is displaced slightly and released, it oscillates to and fro under the action of gravity.

For small Angular displacements the motion of the simple pendulum is simple harmonic (SHM) The period of oscillation depends on the length of the bob and the

*Controlled variables*; initial pointer reading, same string constant, temperature

***Materials and apparatus***

- Spring
- mass hanger and slotted masses
- meter rule
- retort stand and clamp
- pointer

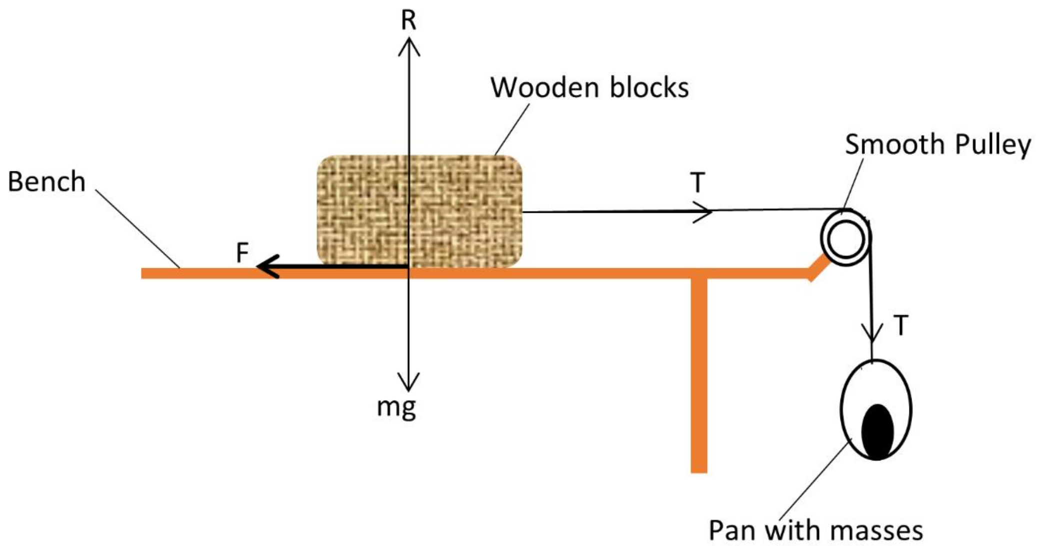
Alternatively, ***a graph of m against e can be plotted and the constant obtained.***

## 8.3.1 Determination of the coefficient of fiction between the two surfaces in contact.

***Principle and theory behind this experiment.***

When one surface moves or tends to move over another surface a force called friction opposes the motion. The coefficient of fiction is the ratio of the friction of force to the normal reaction between the surfaces.

***Experimental diagram***



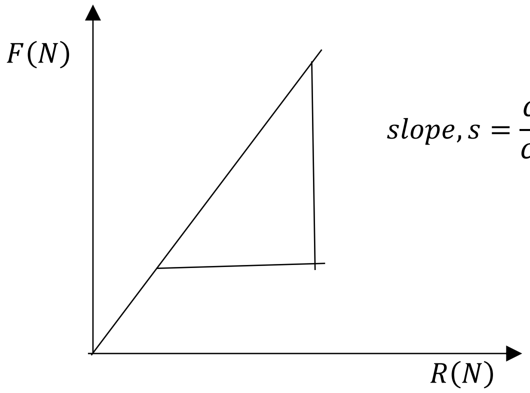

**Mathematically**;

$F = \mu \mathrm{R}$

Hence: $\mu = \frac{F}{N}$

The equation $F = \mu \mathrm{R}$ is in the form $y = mx$, thus a graph of $F$ against $R$ is linear with a slope, s, equal to $\mu$.

***Outlook of the graph***




$$slope, s = \frac{change\ in\ \ F(N)}{change\ in\ R(N)}$$

***Variables involved***

*Independent variable*; normal reaction, R varied by adding masses.

*Dependent variable*; friction force $F$.

*Controlled variable*; nature of surfaces, contacted area, mass of empty scale pan.

***Materials and apparatus***

- Wooden block.
- Rough horizontal surface.
- Pulley
- Mass hanger and slotted masses.
- Spring balance (optional).
- Light string

## 8.4.1 Determination of unknown mass of an object using principle of moments.

***Principle and Theory behind this experiment.***

The principle of moments states that for a body in equilibrium the sum of clockwise moments about a point is equal to the sum of ant clockwise movements about the same point.

***Experimental diagram***

The slope ,$s$, of the graph is obtained and the unknown mass $m$ is got from the expression $m = m_1 s$

> **Note**
> A single reading calculation is possible but graphical analysis improves accuracy.

***Variables involved.***

*Independent variable*; distance, $d_1$, of the known mass from the pivot.

*Dependent variable*; distance ,$d$, of the unknown mass from the pivot.

*Controlled variables*; pivot position, gravitational field and standard mass.

***Materials and apparatus***

- Knife edge or pivots
- Meter rule
- Known masses
- Mass hanger
- Unknown mass
- Thread

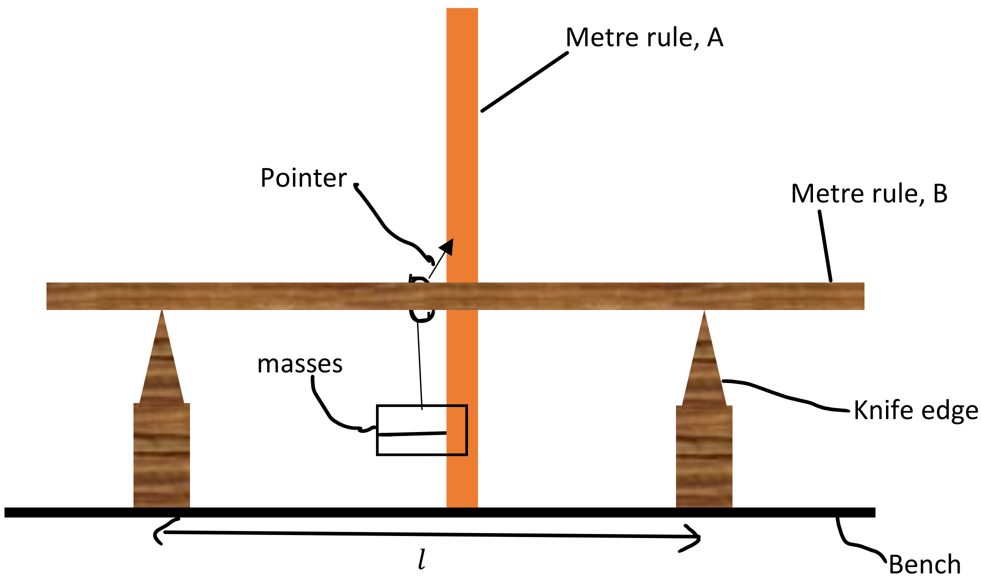
## 8.5.1 Determination of young's modulus of a metre rule.

***Principle and theory behind this experiment.***

When a beam is loaded and bends slightly. It undergoes elastic deformation provided elastic limit is not exceeded, the deformation is proportional to the applied force.

Young's modulus is a measure of the stiffness of a material of the meter rule.

***Experimental diagram.***




For a meter rule supported at both ends and loaded at the center.

$$Y = \frac{Wl^3}{4bd^3y}$$

Where;

$W = mg =$ load applied

$l =$ length between supports

$b =$ breadth of the meter rule

$d =$ thickness of the meter rule

$Y =$ young's modulus

$y =$ deflection of the centre (depression)

Re arranging the equation $Y = \frac{Wl^3}{4bd^3y}$ to make $y$ the subject

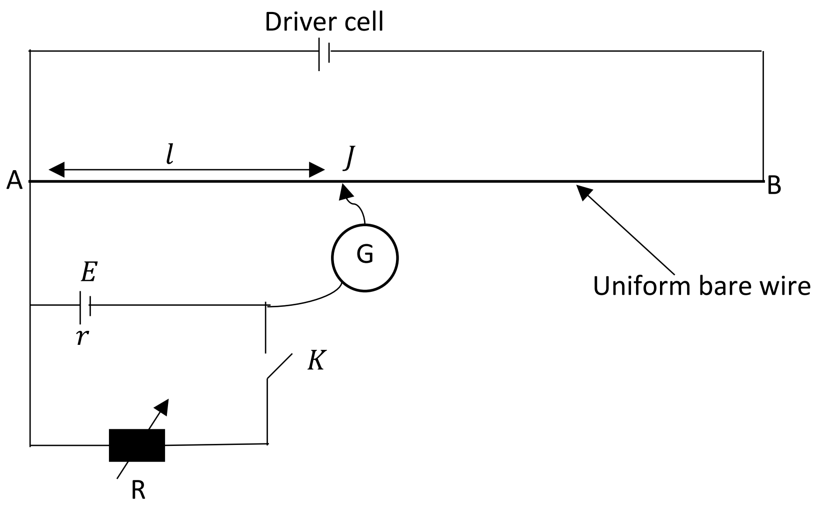
$$y = \frac{l^3}{4bd^3Y}W$$

But $W = mg$

Substituting for W

$$y = \frac{gl^3}{4bd^3Y}m$$

***Experimental diagram***




For a uniform potentiometer wire, potential difference is proportional to the length.

When the cell is not supplying current.

$$E \propto l_0$$

$$E = kl_0$$

But $E = I(R + r)$

Hence $I(R + r) = kl_0$……………………………………(i)

When the cell is supplying current through an external resistance

$$V \propto l_1$$

$$V = kl_1$$

But $V = IR$

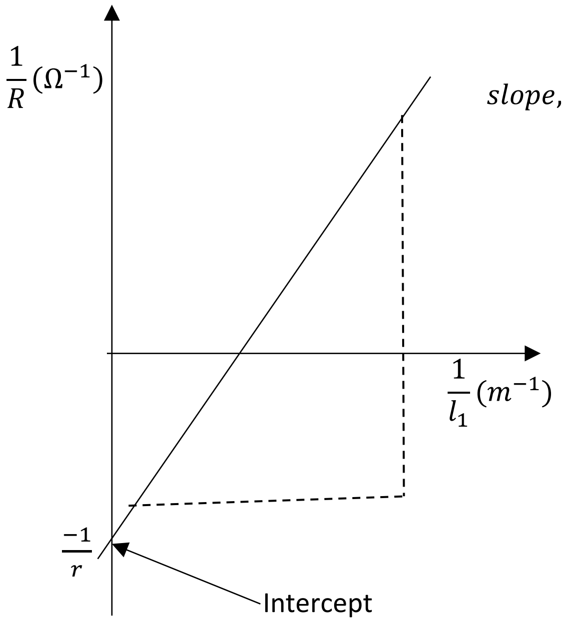
Thus $IR = kl_1$…………………………………………… Eqn (ii)

Dividing Eqn(i) by Eqn(ii) and simplifying we get;

$$\frac{1}{R} = \left(\frac{l_0}{r}\right)\left(\frac{1}{l_1}\right) + \left(\frac{-1}{r}\right)$$

The equation $\frac{1}{R} = \left(\frac{l_0}{r}\right)\left(\frac{1}{l_1}\right) + \left(\frac{-1}{r}\right)$ is in the form $y = mx + C$, thus a graph of $\frac{1}{R}$ against $\frac{1}{l_1}$ is linear with a slope, s, equal to $\frac{l_0}{r}$ and a y – intercept equal to $\frac{-1}{r}$.

***Outlook of the graph.***




$$slope, s = \frac{change\ in \frac{1}{R}\ (\Omega^{-1})}{change\ in\ \frac{1}{l_1} (m^{-1})}$$

$Intercept = \frac{-1}{r}$

Thus, $r = \frac{-1}{intercept}$.

Alternatively

$slope, s = \frac{l_0}{r}$

Thus, $r = \frac{l_0}{s}$

***Variables involved.***

*Independent variable*: external resistance *R*

*Dependent variable*: balance length, $l_1$

*Controlled variables*: current in potentiometer wire, temperature of the wire

***Material and apparatus***

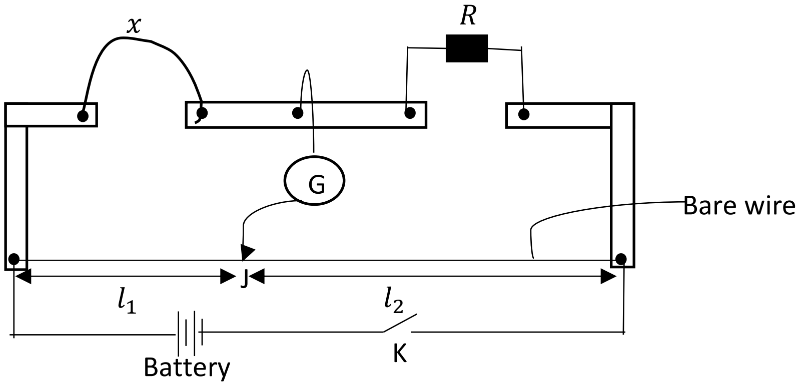
- Potentiometer
- Dry cell (Driver cell)
- Test cell
- Rheostat (resistance box)
- Centre zero galvanometer
- Jockey
- Connecting wire
- Switch

## 8.10.1 Determination of resistivity of the material wire.

***Principle and theory behind this experiment.***

The resistivity of a material is a property that depends on the nature of the material and temperature, but not on its dimensions. It can be determined by measuring the resistance, length and cross-sectional area of the wire. The resistance per unit length can be got using the meter bridge as a slope and multiplied by the cross-sectional area to get the resistivity of the wire.

***Experimental diagram***




**Note** $l_2 = 100 - l_1$

Where;

$x =$ known length of the wire with resistance $R_x$ whose resistivity is to be determined.

$R =$ standard resistance

$l_1 and\ l_2 =$ balance lengths.

$j =$ jockey

$G =$ Centre zero galvanometer.

$K =$ Switch

At balance (when the galvanometer shows no deflection.)

$$\frac{R_x}{R} = \frac{l_1}{l_2}$$

Thus, $R_x = R\left(\frac{l_1}{l_2}\right)$

Resistance of a uniform wire is given by:

$$R_x = \rho\left(\frac{x}{A}\right)$$

Hence $R_x = \left(\frac{\rho}{A}\right)x$

# CHAPTER 9: WORKED OUT EXAMPLES.

## 9.1 Sample item 1

At a local produce-weighing point in Mbale, a trader uses a home-made balance beam to estimate the mass of items when a standard weighing scale in unavailable. Recently, the trader has been receiving complaints from customers that mass of the sealed packets of groundnuts he sells to them is not the exact one and he need to confirm it by determining the mass using other method but he is stuck on what to do next.

The trader is informed that the mass of the sealed package lies in in the range $40.0\ g \leq m \leq 70.0\ g$ but the exact value is unknown. The trader has requested your help to determine the mass of the sealed packet.

**Task**

As a physics student, advise the business man about the customer's complaint.

### 9.1.1 Laboratory report for sample item 1

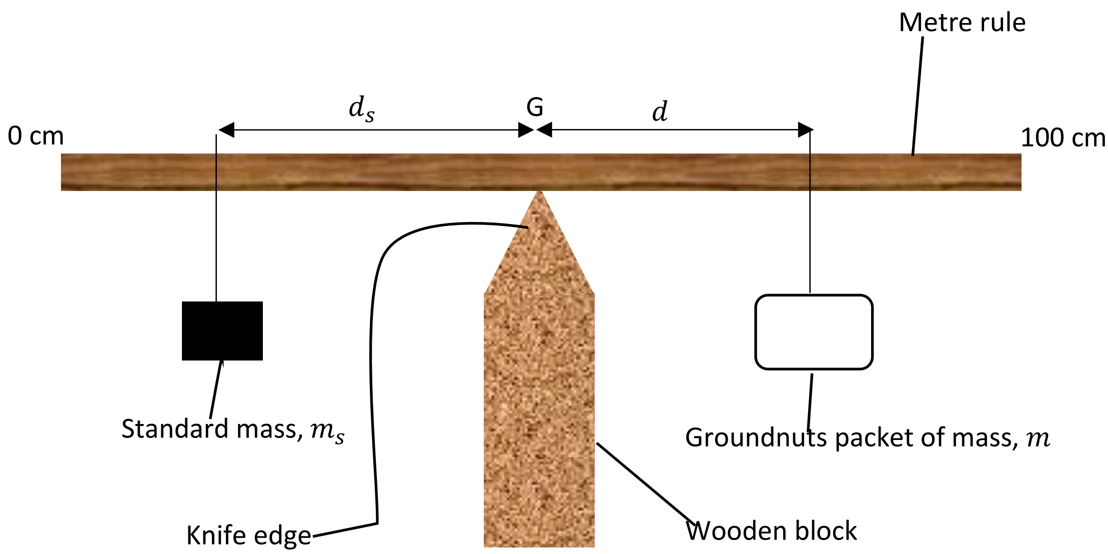
***Aim***

*A scientific investigation to determine the mass, $m$ , of a sealed packet of groundnuts to advise the trader on the customer's complaint.*

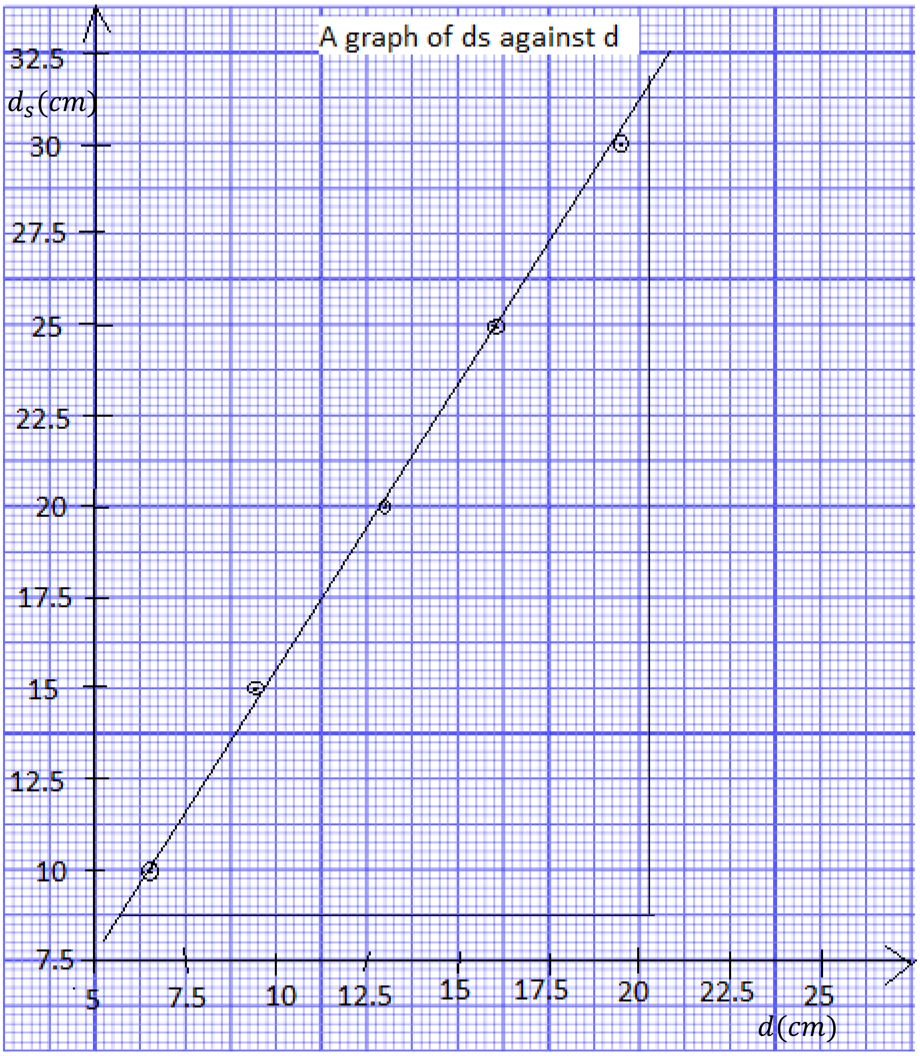
***Theory of the experiment.***

The principle of moments states that for a body in equilibrium the sum of clockwise moments about a point is equal to the sum of ant clockwise movements about the same point.

***Diagram***




For equilibrium about the pivot




*From the graph*

$$Slope = \frac{(d_s)_2 - (d_s)_1}{(d)_2 - (d)_1}$$

$$S = \frac{31.50 - 8.75}{20.25 - 6.00}$$

$$S = \frac{22.75}{14.25}$$

$$S = 1.596$$

*Mass of the sealed packets* $m_1 = 1.596 \times 30 = 47.88\ g$

*Mass of the sealed packets* $m_2 = 45.23\ g$

*From* $m = \frac{m_1 + m_2}{2}$

$$m = \frac{47.88 + 45.23}{2}$$

$$m = 46.56\ g$$

***Conclusion and Advise***

*The mass of the sealed packets of groundnuts is* $46.56\ g$ *which is in the range 40.0 g to 70.0 g hence the hypothesis is accepted.*

*There for the problem is not the weighing scale. Therefore, I advise the trader to look for another cause of customer's complaints.*

# 9.2 Sample item 2

At a mobile phone repair shop in Fort Portal, a technician receives a resistor whose color bands have faded and can no longer be read. The technician needs to know the resistance of a component before using it in the in the sensitive electric circuit. The technician is informed that the resistance of the component is expected to lie within the range; $1\Omega \leq R \leq 3\Omega$.

However, the expected value is NOT known. The technician has therefore requested your help to determine the resistance of the component.

**Task 2**

You are provided with a resistor with the same specification like the one received by the technician, advice the technician on the suitability of the resistor.

## 9.1.2 Laboratory report for sample item 2

***Aim***

*A scientific investigation to determine the resistance,* $R$*, of a component so as to advise the technician on its use in the sensitive electric circuit.*

***Theory of the experiment.***

A meter bridge operates on the principle of a Wheatstone bridge

When the bridge is balanced, the ratio of two resistances is equal to the ratio of the lengths of the bridge wire on either side of the balanced point.