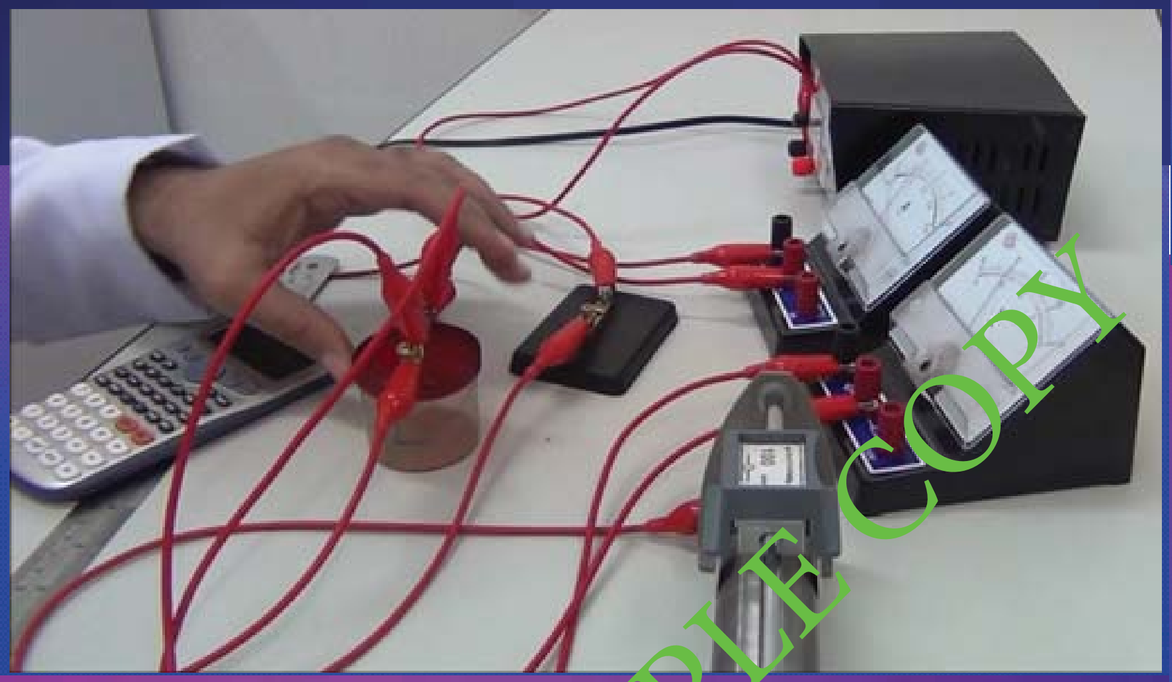

UCLSE NEW CURRICULUM PHYSICS PRACTICAL WORK BOOK

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Physics

Practical Workbook

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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.

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.

Experiment 18

A small mass is attached to a length of thread as shown in Figure **18**. This is referred to as the plumbline.

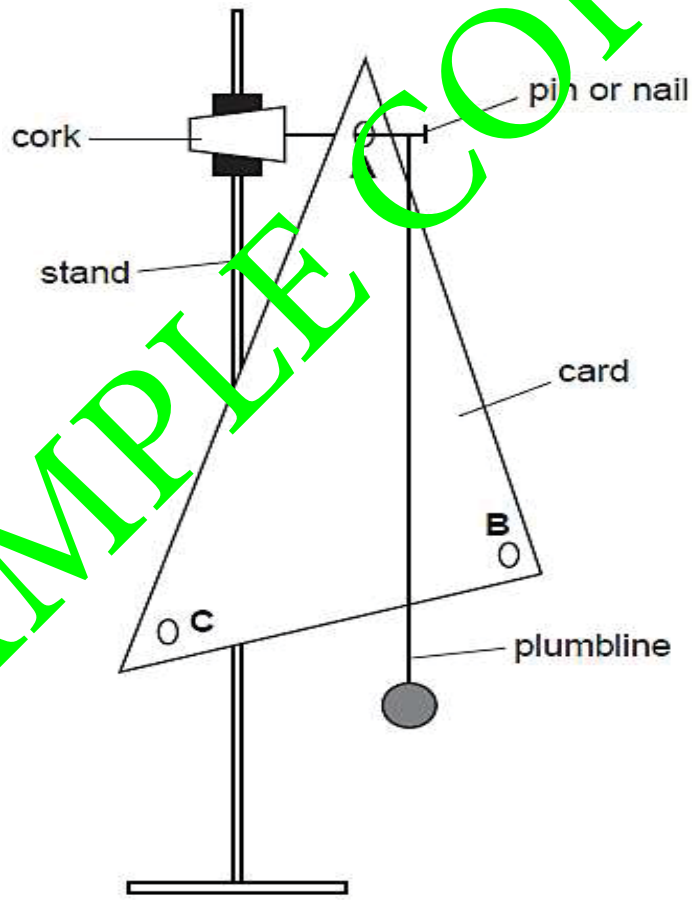


Fig. 18

(a) Suggest a suitable title for this experiment.

……

……

(b) Carry out the following instructions referring to Figure **18**.

(c) Measure and record the lengths of the three sides of the triangular sheet of card.

length 1 = ……

length 2 = ……

length 3 = ……

(01 mark)

(d) (i) Hang the card on the nail through hole **A**.

(ii) Hang the plumbline from the nail so that it is close to the card but not touching it.

(iii) When the card and plumbline are still, make a small mark at the edge of the card where the plumbline crosses the edge.

(iv) Remove the card and draw a line from the mark to hole A.

Experiment 12

Imagine you are conducting an experiment to investigate the period of a pendulum. The apparatus is set up as described in the instructions, and you refer to Figure **12.1** and Figure **12.2**. Follow the given steps to perform the experiment.

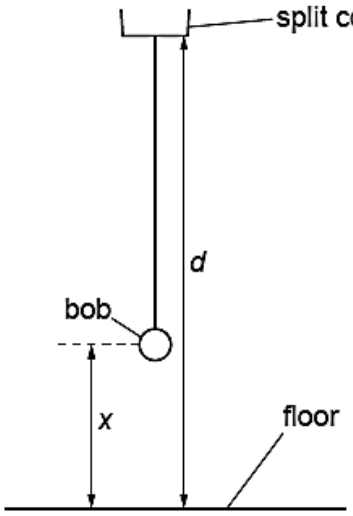


Fig. 12.1

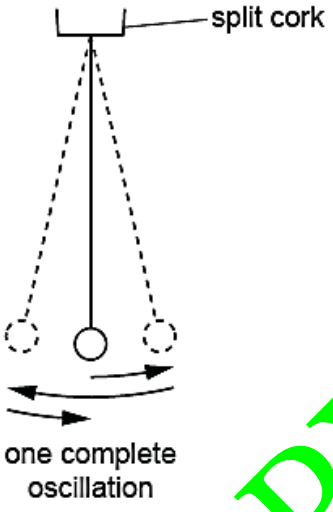


Fig. 12.2

(a) Start by measuring the distance d between the bottom of the split cork and the floor.

$d =$ ……cm *(01 mark)*

This distance d must remain constant throughout the experiment.

(b)
- Adjust the length of the pendulum until the distance x, measured from the centre of the bob to the floor, is 50.0 cm.
- Displace the bob slightly and release it so that it swings. Figure **12.2** shows one complete oscillation of the pendulum.
- Measure, and record in Table **12**, the time t for 10 complete oscillations.
- Calculate, and record in Table **12**, the period T of the pendulum. The period is the time for one complete oscillation.
- Calculate, and record in Table **12**, T^2. *(02 marks)*

Table **12**

$x(cm)$	$t(s)$	$T(s)$	$T^2(s^2)$
50.0			
45.0			
40.0			
35.0			
30.0			

(c) From the experiment described above, identify:

(i) The independent variable ……

(ii) The dependent variable ……

(iii) The constant variable ……

(d) Repeat the procedure in (b) using x = 45.0 cm, 40.0 cm, 35.0 cm and 30.0 cm.

(03 marks)

(e) Plot a graph of T^2 (*along the vertical axis*) against x (*along the horizontal axis*). You do not need to start your axes at the origin (0,0). *(04 marks)*

(f) Explain why timing 10 oscillations gives a more accurate result for the period T than timing one oscillation. *(01 mark)*

(i) Measure and record in Table **25** the angle of incidence i between the line **AN** and the normal. Measure, and record in the table, the angle of reflection r between the normal and the line passing through P_2 and P_3.

Table 25

edge	$i(^o)$	$r(^o)$
A		
B		

(03 marks)

(j) Repeat the steps **(e)** – **(i)** but using edge **B** of the card instead of edge **A**.

(k) In spite of carrying out this experiment with care, it is possible that the values of the angle of reflection r will not be exactly the same as the values obtained from theory. Suggest **two** possible causes of this inaccuracy.

1. ……

……

2. ……

……

(02 marks)

Insert your ray−trace sheet opposite this page. *(05 marks)*

Experiment 26

Concave mirrors curve inward and are thicker at the center than at the edges, causing light rays parallel to the optical axis to converge. These mirrors are employed in applications such as reflecting telescopes for gathering and focusing light in astronomy, and in cosmetic mirrors where their ability to produce enlarged and upright images is utilized for personal grooming. However, it is necessary to determine the focal length, f of a concave mirror before its use.

(a) A concave mirror is placed in a holder and used to focus light from a window onto a screen. The screen is adjusted until a sharp image is formed on it.

(i) Measure and record the distance d, between the screen and mirror.

d = …… *(01 mark)*

(ii) Explain the meaning of distance . *(01 mark)*

……

……

(b) Arrange the apparatus as shown in figure **38**. Adjust the distance, u, of the torch bulb from the mirror to 15cm. Close switch K. Adjust the position of the white screen, S_2 until a sharply focused image of the wire gauze appears on it. Open switch K.

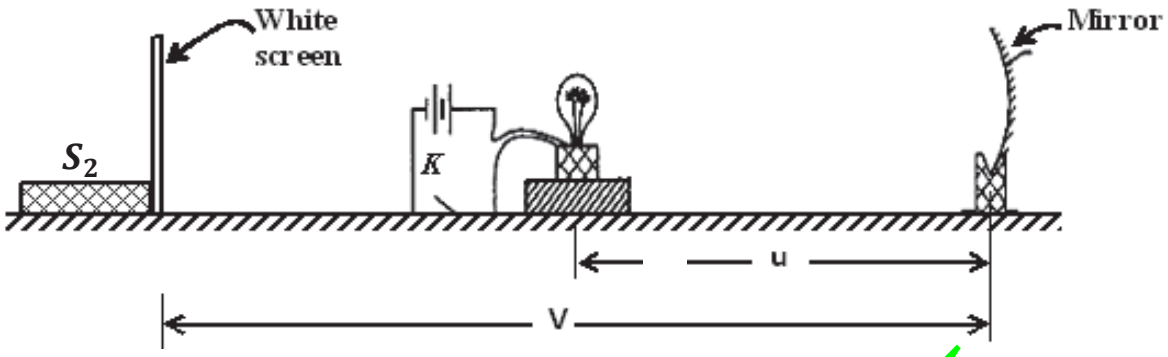


Fig. 38

(c) Measure and record the distance, v of the screen S_2 from the mirror.

v = ... *(01 mark)*

(d) Calculate the values of $y = V - d$ and $x = u - d$.

y = ... *(01 mark)*

x = ... *(01 mark)*

(e) Repeat procedures (f) to (h) for values of $u = 35.0, 40.0, 45.0, 50.0$ and $55.0cm$.

(f) Tabulate your results including values of $\frac{1}{x}$.

Table 38

(06 marks)

(g) From the experiment described above, identify:

(i) The independent variable ……

(ii) The dependent variable ……

(iii) The constant variable ……

(h) Plot a graph of y against $\frac{1}{x}$. *(06 marks)*

(i) Determine the slope, *S* of the line of best fit.
Show your working and indicate on the graph the values you use to calculate the gradient *G*.

S = ... *(02 marks)*

(j) Calculate the value of f_1 from $f_1 = \sqrt{S}$.

f_1 = ... *(02 marks)*

(k) Determine the value of the constant, f of the concave mirror using $\boldsymbol{f} = \frac{1}{2}(f_1 + d)$

B ..... *(02 marks)*

Experiment 27

This experimental investigation has two part, (I) and (II).

PART I

A concave mirror is mounted in a mirror holder and a pin in cork is placed such that its pointed end lies along the axis of the mirror. The pin is moved towards and away from the mirror until it coincides with its image by no-parallax.

(a) Suggest a suitable title for this experiment. *(01 mark)*

……

……

(b) State **one** suitable hypothesis that could be investigated. *(01 mark)*

……

(c) With the apparatus provided, set up this experiment. Measure and record the distance, N between the pin and the mirror.

N ..... *(01 mark)*

(ii) Calculate, the quantity, from: B L $^{S}W_{t}$ N

f = ... *(02 marks)*

PART II

(a) Set up a new arrangement of apparatus as shown in Figure **27**. Place the mirror, wire gauze and bulb such that distance, T L s wB

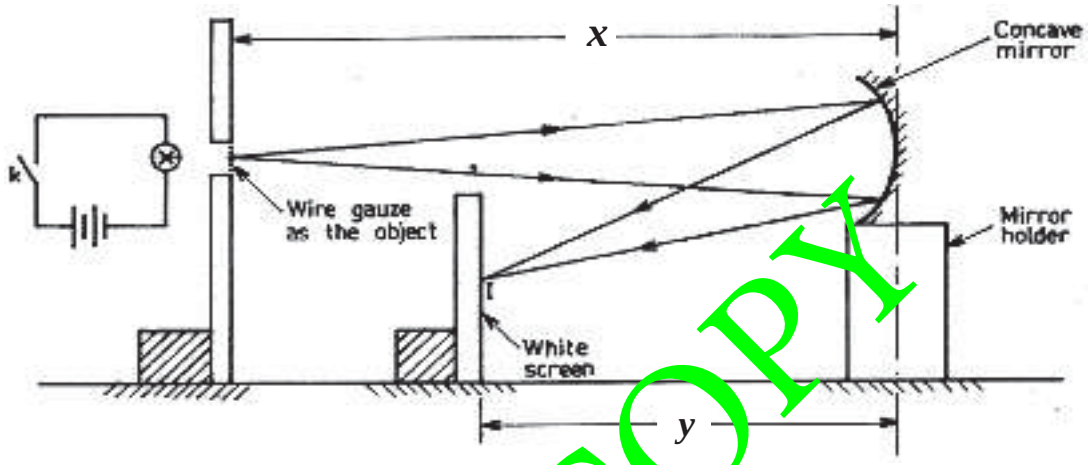


Fig. 27

Close switch, -and adjust the position of the screen until a clear image of the wire gauze is obtained on the screen.

(i) Measure and record the distance, Ubetween the mirror and screen.

U ..... *(01 mark)*

(b) Repeat procedures a) to (i) for T L t rBAt wBAu wBAv rBand v wB

(c) Tabulate your results including values of $-\frac{U}{T}$ *(06 marks)*

.....

.....

.....

.....

.....

.....

.....

.....

.....

(d) From the experiment you have just carried out, state; *(04 marks)*

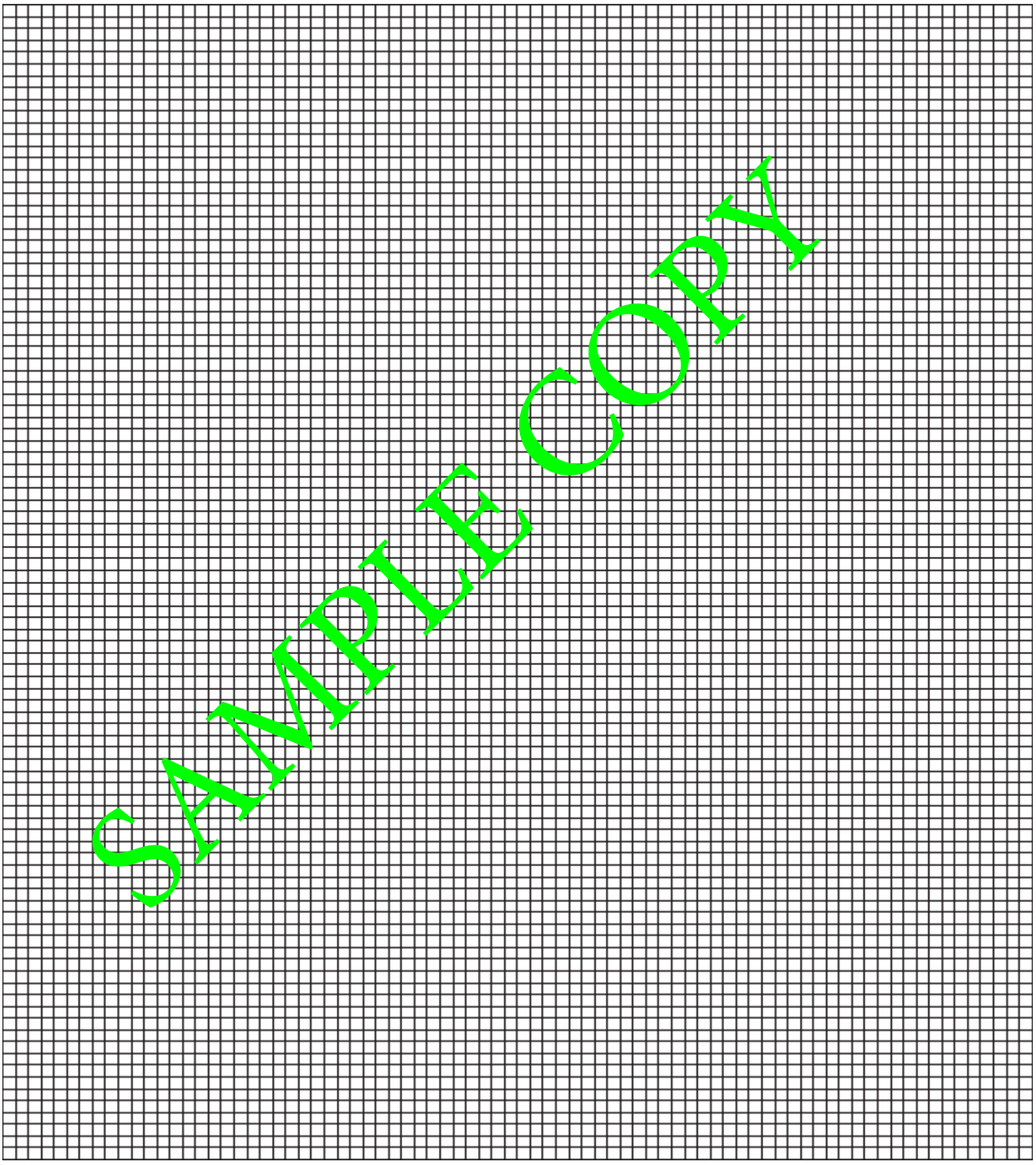
(i) The aim of the experiment ……
……

T (ii) The independent variable ……

(ii) The dependent variable ……

(iii) The constant variable ……

(e) Plot a graph of $\frac{y}{x}$ against y. *(06 marks)*



(g) The resistance R_W of the wire is calculated using the equation: $R_W = \frac{22}{N}$

where $N = \frac{V_S}{100G} - 1$

Use your value of V_S recorded in **(b)** and your value of G calculated in **(f)** to calculate R_W.

Show your working.

R_W = ……Ω *(01 mark)*

Experiment 48

In this experiment you will investigate the resistance of a light-emitting diode (LED).

You are provided with:

- a power supply
- a light-emitting diode
- 5 resistors of resistance 150 Ω
- a switch
- connecting wires and crocodile clips.

The supervisor has set up the circuit shown in Figure **48**.

The crocodile clip shown in the diagram in Figure **48** is a movable contact that can be attached at different points in the circuit.

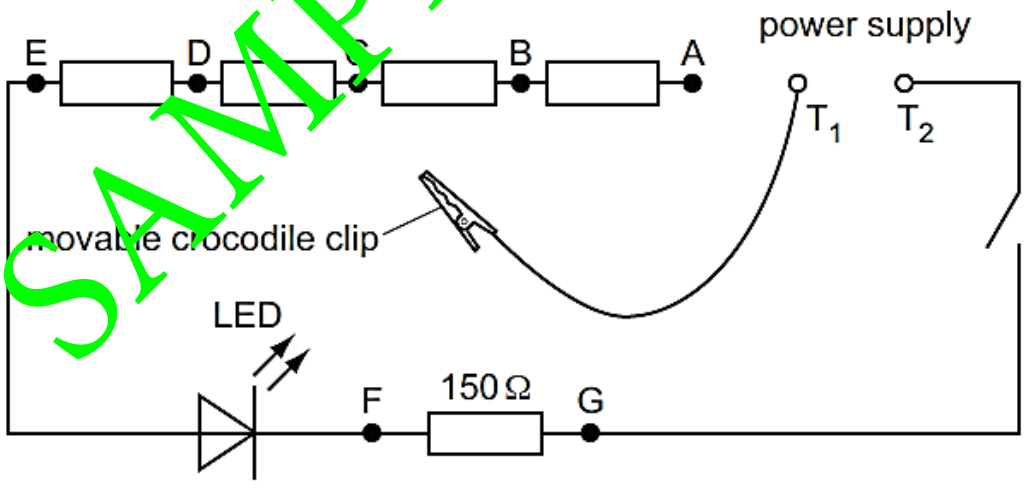


Fig. 48

You are also provided with a voltmeter and two additional connecting wires.

(a) (i) Make sure that the movable crocodile clip and wire is not touching any other part of the circuit.

Connect the voltmeter between the terminals T_1 and T_2 of the power supply. Record the reading V_S on the voltmeter.

Disconnect the voltmeter from the power supply.

V_S = ……V *(01 mark)*

(ii) Attach the movable crocodile clip to one of the wires either side of the crocodile clip labelled A.

Connect the voltmeter between F and G.

Close the switch.

Record the reading V on the voltmeter.

Open the switch.

V_S = ……V *(01 mark)*

(iii) Using your answer from **(a)(ii)**, calculate the current I_{LED} in the LED using the equation $I_{LED} = \frac{V}{150}$

I_{LED} = ……A *(01 mark)*

(iv) The total number of resistors connected in series with the LED is n. When the movable crocodile clip is attached by A, the value of n is 5.
Using your answers from **(a)(i)** and **(a)(ii)**, calculate the voltage V_{LED} across the LED using the equation

$V_{LED} = V_S - nV$.

V_{LED} = ……A *(01 mark)*

(v) Using your answers from **(a)(iii)** and **(a)(iv)**, calculate the resistance R_{LED} of the LED using the equation

$$R_{LED} = \frac{V_{LED}}{I_{LED}}$$

R_{LED} = ……Ω *(01 mark)*

(b) (i) In the appropriate row in Table **48**, record your readings and calculations from **(a)(ii)**, **(iii)**, **(iv)** and **(v)**.

Add appropriate headings with units to each column. *(01 mark)*

(ii) Repeat the procedure in **(a)(ii)** to **(a)(v)** with the movable crocodile clip connected by B, C, D and E.

Record your readings and calculations in Table **48**.

Table 48

Position of crocodile clip	*n*				
by A	5				
by B	4				
by C	3				
by D	2				
by E	1				

(03 marks)

(c) From the experiment described above, identify: *(03 marks)*

(i) The independent variable ……

(ii) The dependent variable ……

(iii) The constant variable ……

(d) Using the grid on next page, plot a graph of R_{LED} (*along the vertical axis*) against I_{LED} (*along the horizontal axis*). Draw the curve of best fit. *(04 marks)*

(e) The values of the supply voltage and the resistance of the resistors have been carefully selected for use with this LED in this practical exercise.

Suggest **two** reasons why these values are suitable.

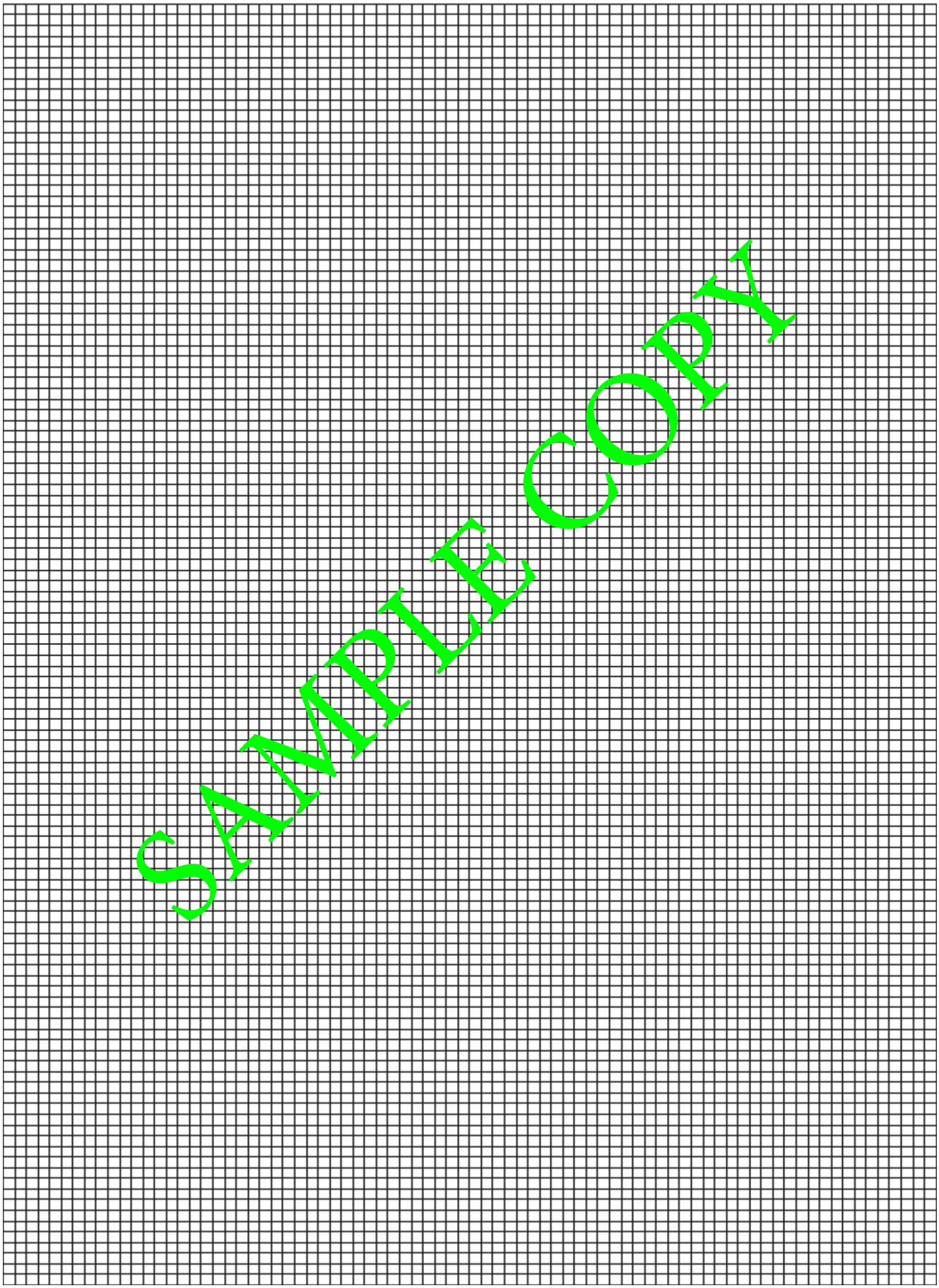
1. ……

……

2. ……

……

(04 marks)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