MACHAKOS UNIVERSITY

University Examinations 2022/2023

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION TECHNOLOGY)

SPH 204: APPLIED PHYSICS LAB II

DATE: **TIME:**

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** (Practical) is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (Theory on Practical) (each 20 marks).

SECTION A (PRACTICAL)

QUESTION ONE (30 marks)

In this experiment you will investigate an electrical circuit.

You are provided with several groups of resistors connected in parallel.

Part I

• Select a group of resistors and assemble the circuit shown in Fig.1.

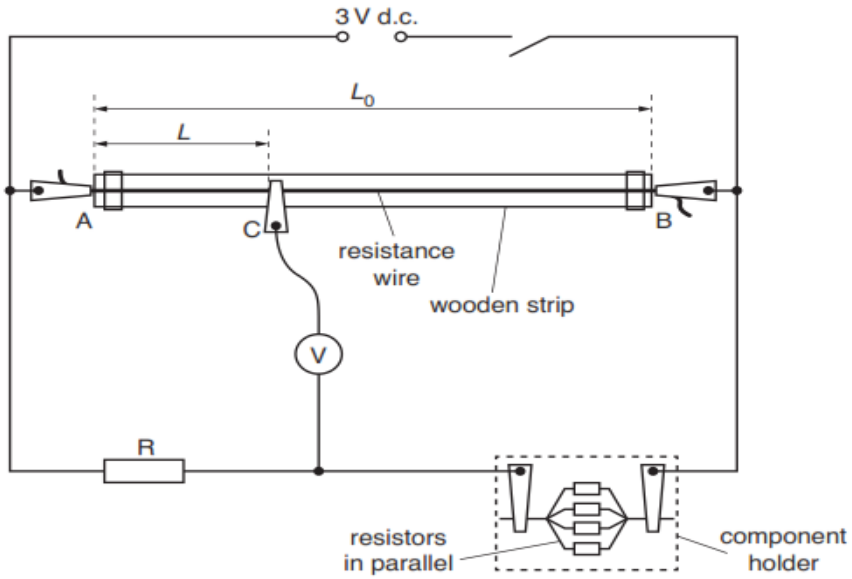


Figure 1

A, B and C are crocodile clips.

a) Measure and record the length ***L*** (2 marks)

Part II

b) Record the number ***n*** of resistors in parallel connected in the component holder.

(i) ***n*** = ... (2 marks)

• Close the switch.

• Move C along the wire until the voltmeter reading is zero.

• Measure and record the distance ***L*** between A and C when the voltmeter reading is zero, as shown in Fig. 1.1.

(ii) ***L*** = ... (2 marks)

• Open the switch.

c) Select a different group of resistors and repeat **(b)** until you have at least six sets of values of ***n*** and ***L***.

Record your results in a table.

Include values of $\frac{1}{n}$ and $\frac{1}{L}$ in your table (10 marks)

d) (i) Plot a graph of $\frac{1}{L}$ on the y axis against $\frac{1}{n}$ on the x-axis (4 marks)

(ii) Draw the straight line of best fit. (2 marks)

(iii) Determine the gradient and the ***y***-intercept of this line. (4 marks)

(e) It is suggested that the quantities ***L*** and ***n*** are related by the equation

$$\frac{1}{L} = \frac{a}{n} + b$$

Where ***a*** and ***b*** are constants.

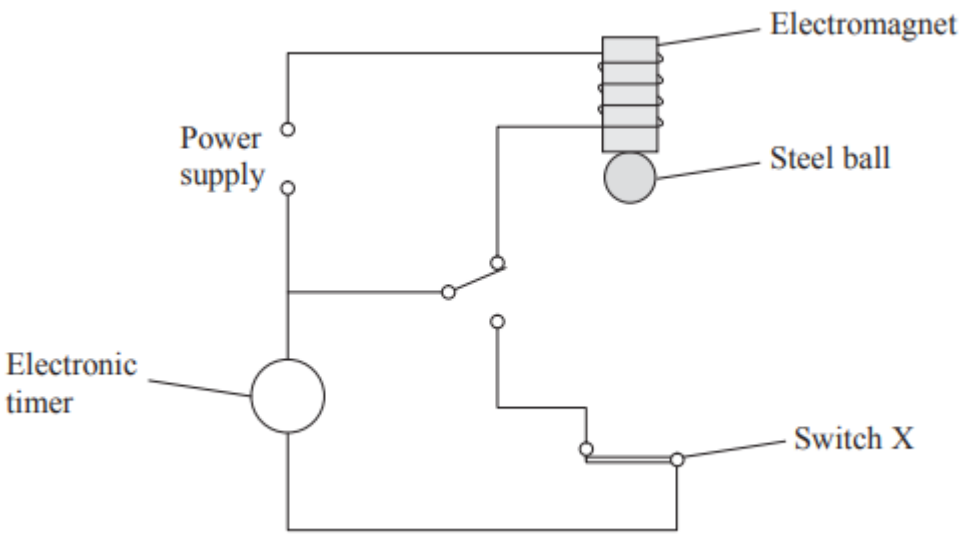
Use your answers in **(d)(iii)** to determine the values of ***a*** and ***b***.

Give appropriate units. (4 marks)

SECTION B

QUESTION TWO

A student is asked to determine a value for the acceleration of free fall g by timing a falling steel ball. The diagram below shows the apparatus to be used. The steel ball falls a distance s from the electromagnet to switch X. The electronic timer records the time taken t.



The student is told to plot a graph of s against t^2

.

Write a plan for an experiment to determine g using this method.

You should:

(a) Draw on the diagram the distance s to be measured, (2 marks)

(b) State the apparatus required to measure s and explain your choice, (3 marks)

(c) Explain why an electronic timer is used to measure t, (2 marks)

(d) Comment on whether repeat readings are appropriate in this case, (2 mark)

(e) Explain what data will be collected and how it will be used to determine g, (6 marks)

(f) Identify the main sources of uncertainty and/or systematic error, (3 marks)

(g) Comment on safety. (2 mark)

QUESTION THREE

A student is asked to investigate how resistance varies with potential difference for a 12 V, 24 W bulbs.

Write a plan for an experiment to do this using standard laboratory apparatus and a graphical method.

You should:

(a) Draw a circuit diagram of the circuit to be used, (3 marks)

(b) State the quantities to be measured, (2 marks)

(c) Explain your choice of measuring instrument for two of these quantities, (4 marks)

(d) Comment on whether repeat readings are appropriate in this case, (2 marks)

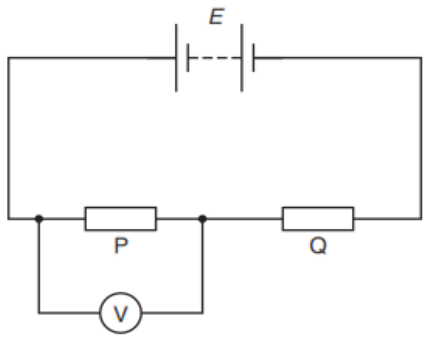
(e) Explain how the data collected will be used and sketch the expected graph, (4 marks)

(f) Identify the main sources of uncertainty and/or systematic error, (3 marks)

(g) Comment on safety. (2 marks)

QUESTION FOUR

A student is investigating the potential difference in a circuit. The circuit is set up as shown in Fig. 2.1.



Two resistors P and Q are connected in series to a power supply of electromotive force (e.m.f.) E and negligible internal resistance. Resistor P has resistance *P*. The potential difference V across resistor P is measured. The experiment is repeated for different values of P. It is suggested that V and P are related by the equation

$$V = \left(\frac{P}{P+Q}\right)E$$

where Q is the resistance of resistor Q. The value of Q is kept constant.

a) A graph is plotted of $\frac{1}{V}$ on the y-axis against $\frac{1}{P}$ on the x-axis. Determine expressions for the gradient and the y-intercept. (2 marks)

b) Values of P and V are given in Fig. 2.2.

P (Ω)	V (V)	$\frac{1}{P}(\times\ 10^{-3}\Omega^{-1})$	$\frac{1}{V}(V^{-1})$
$250 \pm 10\%$	0.66		
$330 \pm 10\%$	0.86		
$470 \pm 10\%$	1.15		
$560 \pm 10\%$	1.30		
$680 \pm 10\%$	1.49		
$840 \pm 10\%$	1.64		

Calculate and record values of $\frac{1}{P}$ $(\times 10^{-3}\ \Omega^{-1}$ and $\frac{1}{V}$ (V^{-1}) in Fig. 2.2. Include the absolute uncertainties in $\frac{1}{P}$. (3 marks)

c)

(i) Plot a graph of $\frac{1}{V}$ (V^{-1}) against $\frac{1}{P}$ $(\times 10^{-3}\ \Omega^{-1}$. (4 marks)

Include error bars for $\frac{1}{P}$.

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labeled. (2 marks)

(iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer. (2 marks)

(iv) Determine the y-intercept of the line of best fit. Include the absolute uncertainty in your answer. (2 marks)

d)

(i) Using your answers to (a), (c)(iii) and (c)(iv), determine the values of E and Q. Include appropriate units. (3 marks)

(ii) Determine the percentage uncertainty in Q. (2 marks)

QUESTION FIVE

The properties of many magnetic materials are affected by temperature. One effect is the loss of permanent magnetism when the temperature of a magnetic material exceeds a particular value. This temperature is known as the Curie point.

Design an experiment to investigate how the magnetic field strength of a magnet depends on the temperature of the magnet in the range from 0 °C to 200 °C. (20 marks)

In your account you should pay particular attention to

(a) the method of measuring the magnetic field strength (magnetic flux density),

(b) how the temperature of the magnet would be measured in the given range,

(c) the method of ensuring that the temperature of the magnet is uniform,

(d) the procedure to be followed,

(e) the control of variables.