MACHAKOS UNIVERSITY

University Examinations 2023/2024 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (TELECOMMUNCATION 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 (COMPULSORY

QUESTION ONE (30 MARKS)

I. In this experiment, you will investigate resistance.

Carry out the following instructions, referring to Figure.1. The circuit has been set up for you.

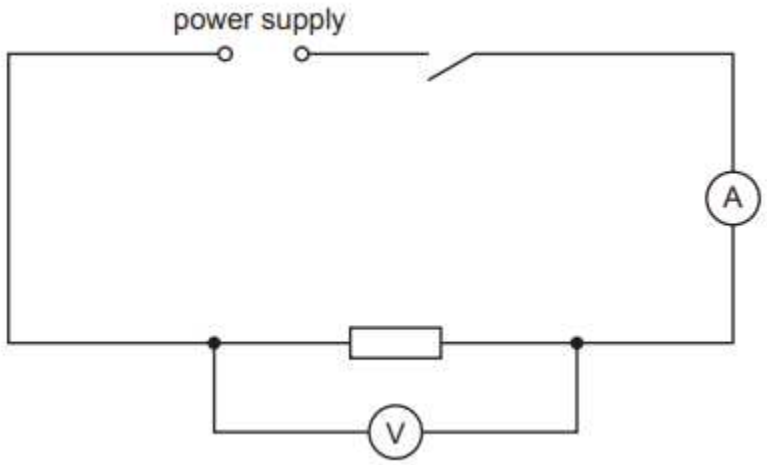

Figure 1

a) Close the switch.

i. Record the current I1 in the circuit. [1 mark]

ii. Record the potential difference (p.d.) V1 across the resistor. [1 mark]
Open the switch.

iii. Calculate the resistance R1 of the resistor using the equation R1 = V1 /I1. (2 marks)

b) Disconnect the voltmeter.

Connect the second resistor provided in series with the first resistor.

Connect the voltmeter across both resistors.

Close the switch.

i. Record the current I2 in the circuit. (1 mark)

ii. Record the potential difference (p.d.) V2 across the resistors. (1 mark)
Open the switch.

iii. Calculate the resistance RS of the resistors in series using the equation RS = V2/ I2 (2 mark)

c) Disconnect the voltmeter. Connect the second resistor in parallel with the first resistor.

Connect the voltmeter across both resistors.

Close the switch.

i. Record the current I3 in the circuit. (1 mark)

ii. Record the potential difference (p.d.) V3 across the resistors. (1 mark)

Open the switch.

iii. Calculate the resistance RP of the resistors in parallel using the equation RP = V3 I3 . (2 marks)

d) Complete the circuit diagram in Figure 2 to show the circuit you used in part (c). (2 marks)

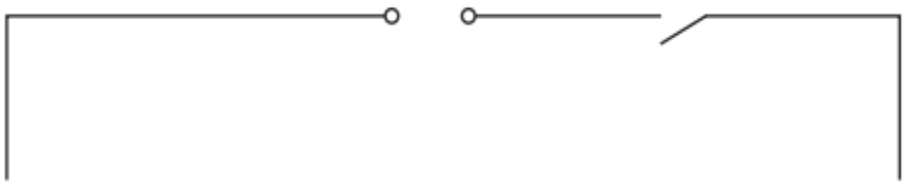

Figure 2

e) Describe how you would extend part (c) of this experiment to investigate the relationship between the combined resistance of identical resistors connected in parallel and the number of resistors. You are not required to do this investigation. (2 marks)

II. Diode characteristics

Apparatus

- a milliammeter
- A voltmeter
- a diode
- a resistor labelled P.

Method

a) Connect the circuit as shown in Figure 3.

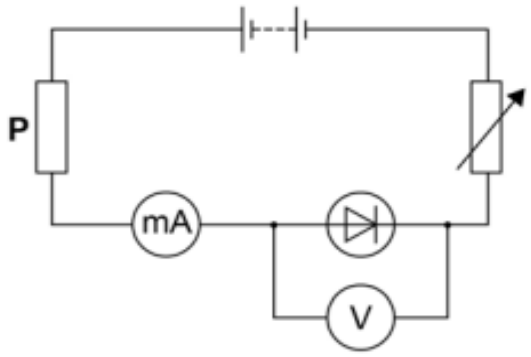

Figure 3

the resistor labeled P as shown.

b) Reduce the battery/power supply potential difference to less than 5 V.

c) Connect

d) Ensure the diode is properly connected in forward bias.

(2 marks)

e) Record the readings on the milliammeter and voltmeter in a suitable table.

f) Adjust the variable resistor and record the new milliammeter and voltmeter readings. Repeat this to obtain several pairs of readings (at least six). (5 marks)

g) Plot a graph of current against potential difference. (5 marks)

h) Comment on the shape of the graph. (2 marks)

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QUESTION TWO (20 MARKS)

A student investigates the rate of cooling, in air, of heated blocks made of different metals. The temperature of each block is increased by placing it in hot water.

Plan an experiment to investigate how the rate of cooling depends on the metal from which each block is made.

You are **not** required to carry out this experiment.

The following apparatus is available to the student:

- Cylindrical blocks of different metals, each with a hole for a thermometer, as shown in Figure 4
- A thermometer.
- Other apparatus normally available in a school laboratory can also be used.

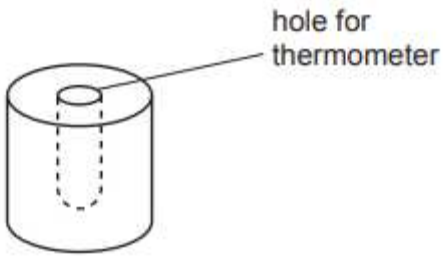

Figure 4

In your plan, you should:

a) List any additional apparatus required (3 marks)

b) Explain briefly how you would carry out the investigation, including the measurements you would take. (6 marks)

c) State the key variables to be kept constant. (3 marks)

d) draw a suitable table, with column headings, to show how you would display your readings

(You are not required to enter any readings in the table) (4 marks)

e) Explain how you would use the results to reach a conclusion. (4 marks)

QUESTION THREE (20 MARKS)

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 Figure 5.

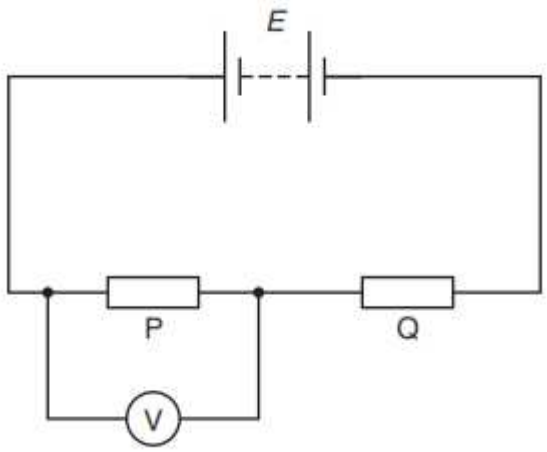

Figure 5

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 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 (20 Marks)

A student is asked to determine a value for the acceleration of free fall g by timing a falling steel ball. The diagram in Figure 6 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.

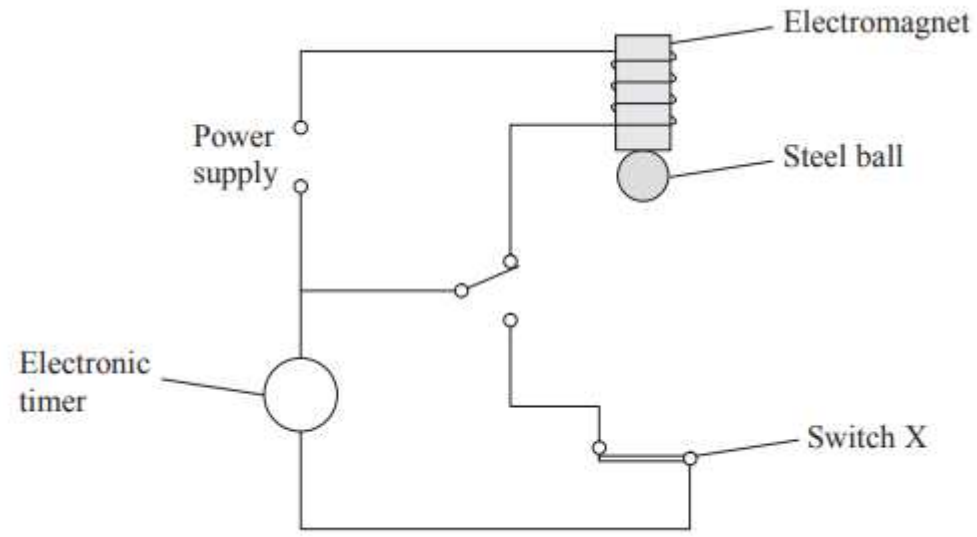

Figure 6

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)