MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SPECIAL NEEDS EDUCATION)

BACHELOR OF EDUCATION (SCIENCE)

SPH 303: PRACTICAL PHYSICS 1

DATE: 2/9/2022 **TIME: 2.00-4.00 PM**

INSTRUCTIONS:

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

CONSTANTS

None

SECTION A (PRACTICAL)

QUESTION ONE (30 MARKS)

In this experiment, you will investigate a pendulum with a mass fixed at each end.

a) • Assemble the apparatus with the nail passing through the third hole from C, as shown in Fig. 1.

• Ensure that the nail is held securely in the clamp.

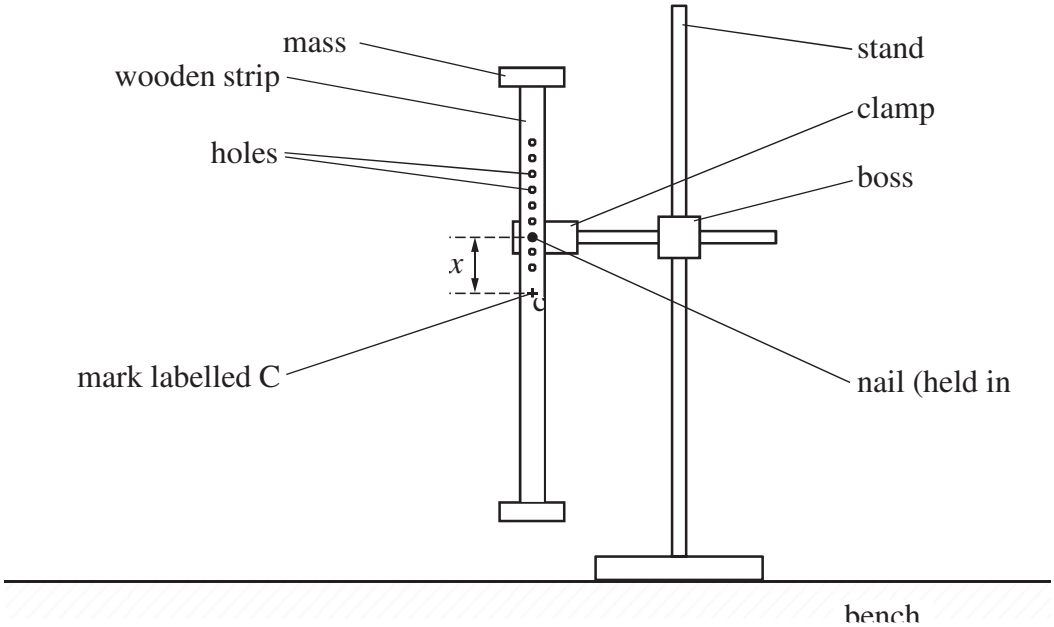

Figure 1

• The distance between the nail and C is x, as shown in Fig. 1.

Measure and record x.

x = ... cm (1 mark)

b) • Push the bottom of the strip horizontally through a distance of approximately 5 cm. Release the strip so that it oscillates.

• Determine the period T of these oscillations. (3 marks)

c) • Change x by positioning the nail in a different hole and repeat (b).

• Repeat until you have six sets of values of x and T.

• Record your results in a table. Include values of $\frac{1}{x}$ and T^2 in your table. (10 marks)

d) i. Plot a graph of T^2 on the y-axis against $\frac{1}{x}$ on the x-axis. (6 marks)

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

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

e) It is suggested that the quantities T and x are related by the equation

$$T^2 = \frac{a}{x} + b$$

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 (THEORY)

QUESTION TWO (20 MARKS)

a) A student is asked to determine the refractive index of glass.

Write a plan for this experiment that uses a rectangular glass block, standard laboratory apparatus and a graphical method.

You should:

i. draw a labeled diagram of the apparatus to be used and list any additional apparatus needed, (2 marks)

ii. show on your diagram the quantities to be measured, (2 marks)

iii. explain your choice of measuring instrument for one of these quantities, (2 marks)

iv. comment on whether repeat readings are appropriate in this case, (1 mark)

v. explain how to determine the refractive index, (4 marks)

vi. identify the main source of uncertainty and/or systematic error, (2 marks)

vii. Comment on safety. (1 mark)

b) A student's uncertainty in recording her reaction time was ± 0.03 s. She recorded a reaction time of 0.38 s.

i. What was the range of her measurements? (1 mark)

ii. Calculate the percentage uncertainty in her measurement. (2 marks)

iii. The student plans to use a stopwatch to measure the time taken for a trolley to move down a slope. She estimates this time to be about 3 s. Comment on her plan. (3 marks)

QUESTION THREE (20 MARKS)

In an experiment to determine the resistivity of the material of a wire, a student measured the diameter of the wire to be 0.56×10^{-3} m.

a) Describe how the student should measure the diameter of the wire. (2 marks)

b) During this experiment, the student kept the current constant at $0.11\ A$ and recorded the following results.

Length / m	Potential difference / V	Resistance / Ω
1.00	0.52	
0.80	0.41	
0.60	0.27	
0.40	0.19	
0.20	0.1	

i. Criticize his results. (2 marks)

ii. Suggest how the student could keep the current constant. (1 mark)

iii. Complete the last column of the table. (2 marks)

c) i. Plot a graph of resistance on the y-axis and length on the x-axis and draw a line of best fit. (5 marks)

ii. Determine the gradient of the graph. (2 marks)

iii. Use your value for the gradient to calculate a value for the resistivity. (4 marks)

iv. There may be a difference between the value in (c) (iii) and the accepted value for the resistivity of the material of the wire. Suggest why there may be a difference. You may assume that your calculations are correct. (2 marks)

QUESTION FOUR (20 MARKS)

A student is investigating monochromatic light passing through a double slit. Bright and dark fringes are produced on a screen as shown in Fig. 2.1.

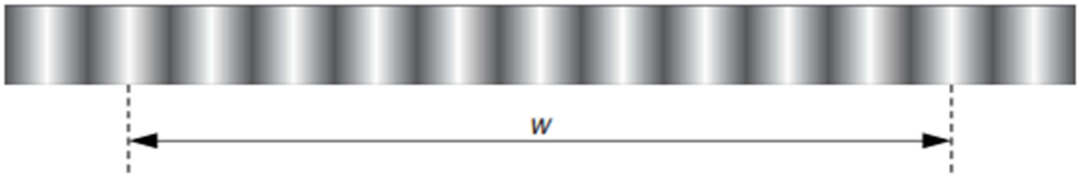

Figure 2.1

The distance ***w*** between 10 bright fringes is measured. The fringe spacing ***P*** between neighboring bright fringes is then determined.

The experiment is repeated for light of different wavelengths λ

It is suggested that the fringe spacing ***P*** and the wavelength λ are related by the equation

$$\frac{P}{D} = \frac{\lambda}{s}$$

where ***D*** is the distance from the double slit to the screen and ***s*** is the slit separation.

a) A graph is plotted of ***P*** on the ***y***-axis against λ on the ***x***-axis.

Determine an expression for the gradient. (1 mark)

b) Values of λ and ***w*** are given in Fig. 2.2.

$\lambda/10^{-7}$ m	*w*/mm	*P*/mm
4.3	39.5 ± 0.5	
4.8	43.5 ± 0.5	
5.3	48.0 ± 0.5	
5.8	52.0 ± 0.5	
6.2	55.5 ± 0.5	
6.6	59.0 ± 0.5	

Calculate and record values of ***P*** (mm) in Fig. 2.2.

Include the absolute uncertainties in ***P***. (3 marks)

c) i. Plot a graph of ***P*** (mm) against λ ($\times 10^{-7}$ m)

Include the error bars for ***P***. (4 marks)

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

iii. Determine the gradient of the line of best fit. Include the absolute uncertainty in your Answer. (3 marks)

d) i. Using your answers to **(a)** and **(c)(iii)**, determine the value of s. Include an appropriate unit.

Data: $D = 2.20 \pm 0.02$ m. (3 marks)

ii. Determine the percentage uncertainty in s. (1 mark)

e) The experiment is repeated using the same double slit but an unknown wavelength λ of light.

The distance between 10 fringes w is measured to be 35.0 ± 0.5 mm.

Determine λ. Include the absolute uncertainty in your answer. (3 marks)

QUESTION FIVE (20 MARKS)

A student is investigating how the extension e of an elastic cord depends on the diameter d of the cord when a force is applied.

The student has a number of elastic cords of the same material with different diameters. The elastic cords have circular cross-sections. Each cord has an unstretched length of approximately 50 cm.

It is suggested that the extension e and the cross-sectional area A of the cord are related by the expression

$$E = \frac{FL}{Ae}$$

where E is the Young modulus of the material of the cord, F is the force applied and L is the unstretched length of the cord.

Design a laboratory experiment to test the relationship between e and d.

Explain how your results could be used to determine a value for E.

a) You should draw a diagram showing the arrangement of your equipment. (3 marks)

b) In your account you should pay particular attention to

i. the procedure to be followed (in reference to the diagram), (5 marks)

ii. the measurements to be taken, (3 marks)

iii. the control of variables, (2 marks)

iv. the analysis of the data, (5 marks)

v. any safety precautions to be taken. (2 marks)