EUNOIA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS 2024
General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME	

CIVICS GROUP	2	3	-			REGISTRATION NUMBER		

PHYSICS

9749/04

Paper 4 Practical

August 2024

2 hours 30 minutes

Candidates answer on the Question Paper.
Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.
The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Give details of the practical shift and laboratory, where appropriate, in the boxes provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	**10**
2	**12**
3	**22**
4	**11**
Total	**55**

This document consists of **20** printed pages and **4** blank pages.

1 In this experiment, you will investigate the effect of friction on a simple pulley system.

(a) You are provided with a spring of unstretched length L_0 , as shown in Fig. 1.1.

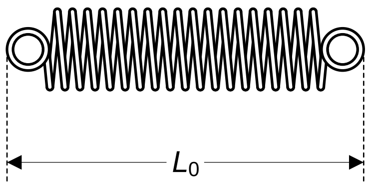


Fig. 1.1

Measure and record L_0 .

L_0 = ...

(b) Set up the apparatus as shown in Fig. 1.2.

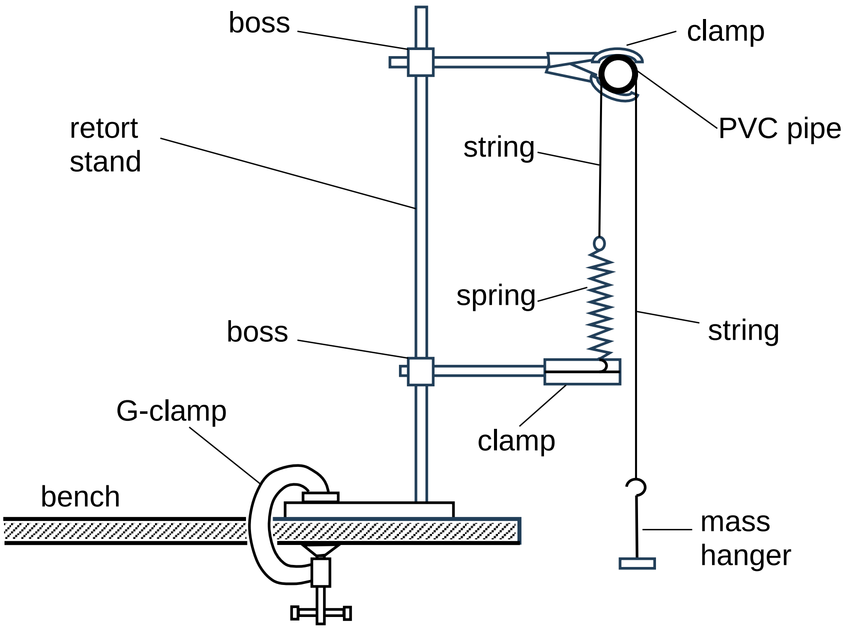


Fig. 1.2

Ensure that the pipe remains horizontal at all times, and that the strings on each side of the pipe are vertical and parallel with each other.

The spring should only stretch minimally at this instant.

(i) Place the 100 g slotted mass onto the mass hanger and **slowly** lower the mass hanger, allowing the spring to extend to a new equilibrium length L_1,

Measure and record L_1.

L_1 = ... [1]

Calculate the extension x_1 of the spring from its unstretched length, where

$$x_1 = L_1 - L_0$$

x_1 = ... [1]

(ii) Estimate the percentage uncertainty in your value of x_1 .

percentage uncertainty in x_1 = ... [2]

(iii) Pull the mass hanger downwards by about 20 cm, causing the spring to extend further. Hold the hanger while allowing it to **slowly** rise upwards until the spring retracts to another equilibrium length L_2, where L_2 is larger than L_1.

Measure and record L_2.

L_2 = ...

Calculate the new extension x_2 of the spring from its unstretched length, where

$$x_2 = L_2 - L_0$$

x_2 = ... [1]

(c) Theory suggests that x_1 and x_2 are related by the expression

$$\ln\frac{x_2}{x_1} = 2\pi\beta$$

where β is a constant.

(i) Using your answers to **(b)(i)** and **b(iii)**, determine a value for β.

β = ... [1]

(ii) The experiment is repeated with different numbers of slotted masses to obtain more values of x_1 and x_2.

State how a straight-line graph can be plotted and used to determine the value of β, assuming the theory is correct.

....

....

....

.... [2]

(iii) State the value of β if the pipe is frictionless. Explain your answer.

....

....

....

.... [2]

[Total: 10]

BLANK PAGE

2 In this experiment, you will investigate the period of a conical pendulum.

Tie one end of the string to the pendulum bob. Place the short plastic ruler on a flat surface such as the top of your stool, bench or floor.

Hold the pendulum directly above one end of the ruler. The length L from the point where you are holding the string to the centre of the bob should be approximately **50 cm**.

Gently swing the pendulum so that the bob performs uniform circular motion just above the ruler, as shown in Fig. 2.1.

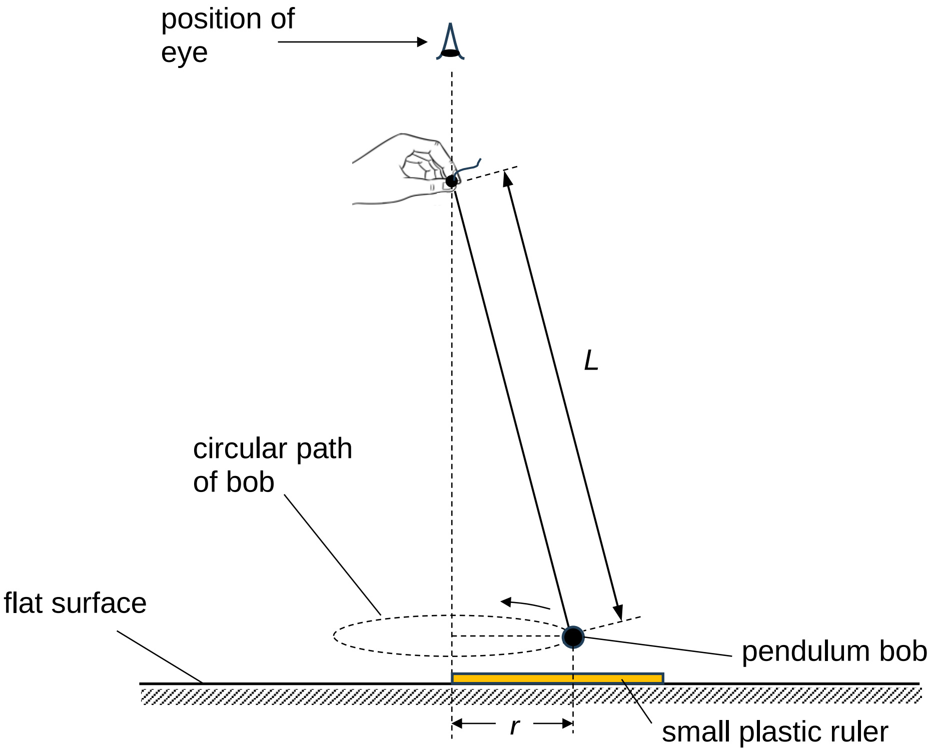


Fig. 2.1

The position of your eye should be vertically above the point where you are holding the string, and the end of the ruler, which is located at the centre of the circular motion. Maintain the position of your eye and the point of suspension of the pendulum.

Swing the pendulum continually so that the radius r of the circular motion about **10 cm**.
(You may want to use a pencil or a pen to point to the desired r value on the ruler for easy reference as you conduct the experiment.)

The period of the conical pendulum is T.

(a) **(i)** Measure and record *r* and *L*.

Determine and record *T*.

r = ...

L = ...

T = ... [1]

(ii) Estimate the percentage uncertainty in your value of *r*.

percentage uncertainty in *r* = ... [1]

(b) Keeping *r* constant at 10 cm, determine *T* for three more values of *L*, where 20 cm $\leq L \leq$ 50 cm.

Tabulate your results.

[3]

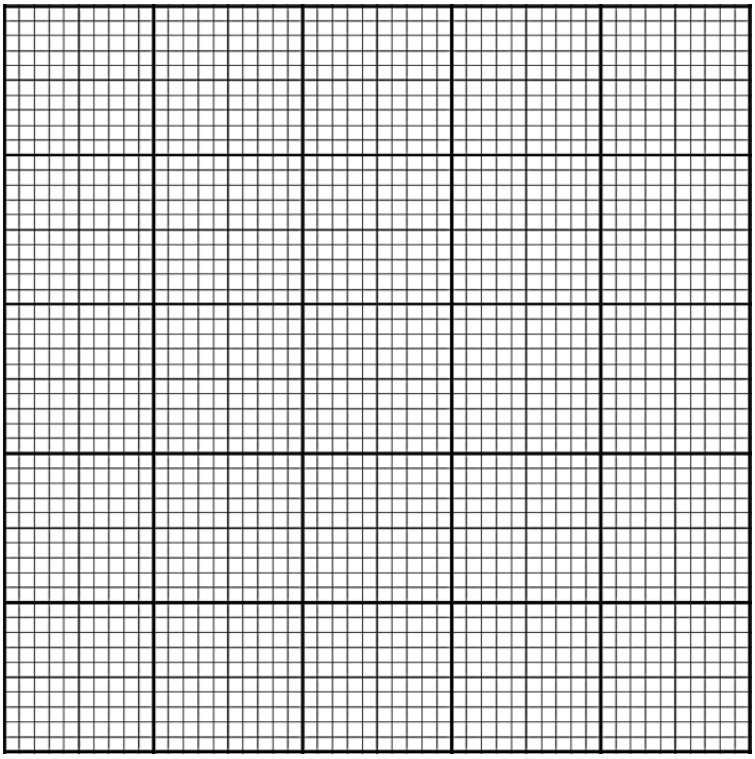
(c) T and L are related by the expression:

$$T^4 = AL^2 - B$$

where A and B are constants.

Plot a suitable graph on the grid below to determine A.

A = ... [3]



(d) Theory suggests that:

$$A = \frac{16\pi^4}{g^2}$$

where g is the acceleration of free fall.

Using your answer to **(c)**, determine a value for g.

g = ... m s^{-2} [1]

(e) The average value for g is 9.81 m s^{-2}.

Show whether your value in **(a)(ii)** explains the difference between the value of g you have determined in **(d)** and the average value for g of 9.81 m s^{-2}.

....

....

....

[2]

(f) It is further suggested that the ratio:

$$\frac{B}{A} = r^2$$

Using this expression, and the expressions provided in **(c)** and **(d)**, sketch a line on your graph grid in **(c)** to show the expected result if the experiment is repeated on the moon.

Label this line M. [1]

[Total: 12]

3 In this experiment, you will determine the characteristics of light emitting diodes (LEDs).

An LED as shown in Fig. 3.1, is a semiconductor light source that emits light of a specific wavelength when current flows through it.

The circuit symbol of the LED is shown in Fig. 3.2.

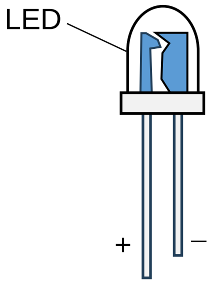


Fig. 3.1

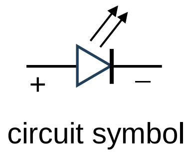


Fig. 3.2

It is very important that the LED is connected to a circuit in the right direction as current can only flow from its positive (+) terminal to its negative (–) terminal. The longer leg is the positive terminal of the LED provided and have been marked with red ink.

(a) Set up the circuit as shown in Fig. 3.3 with the **red** LED connected so that it is conducting. **Use the 20 V range for the voltmeter, and the 20 mA range for the ammeter**.

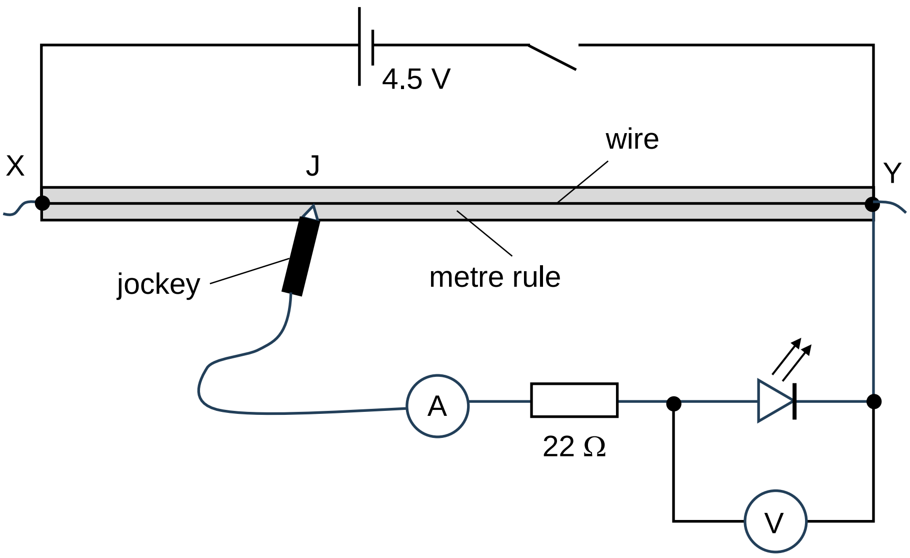


Fig. 3.3

(i) Close the switch.

Move the jockey contact J on the wire XY until the ammeter reading is about 0.1 mA. Record the ammeter reading I and the voltmeter reading V.

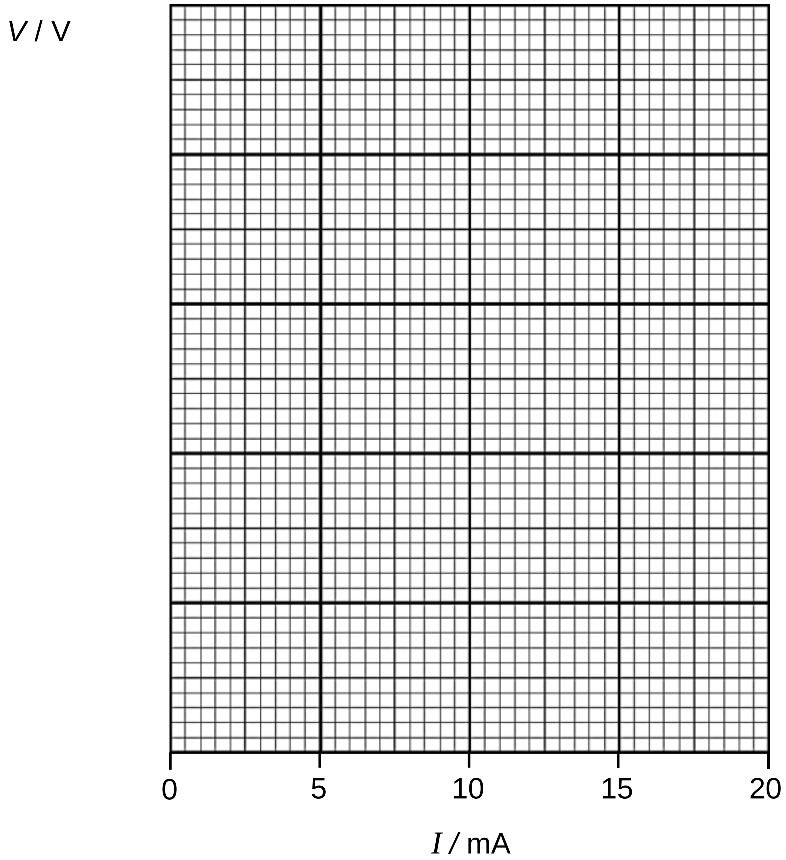
By changing the position of the contact J, obtain 4 more sets of readings of I and V. Ensure that $\boldsymbol{I}$ **< 20 mA.**

Tabulate your results.

I / mA	V / V

Open the switch. [2]

(ii) Plot your results on the grid and draw the line of best fit.



[2]

(iii) With reference to your graph in **(a)(ii)**, suggest how the resistance of the LED varies with the current through it.

....

.... [1]

BLANK PAGE

(b) **(i)** Close the switch.

Move the jockey contact J from end Y gradually towards end X until the LED **just** turns on, i.e. it just emits a red light.

Record the voltmeter reading, V_{min}.

Open the switch.

V_{min} = ... [1]

(ii) Suggest why the 22 Ω resistor is connected in series with the LED.

....

.... [1]

(c) **(i)** The frequencies of LEDs emitting light of different colours are provided as follows:

LED colour	Red	Orange	Yellow	Green	Blue
Frequency / $\times 10^{14}$ Hz	4.51	4.80	5.04	5.31	6.38

Repeat **(b)(i)** for the other LED colours.

Present your results clearly.

[2]

(ii) Theory suggests that the energy lost by an electron in passing through the LED is the energy of the emitted photon, i.e.

$$eV_{\text{min}} = hf$$

where h is the Planck constant and e = 1.60×10^{-19} C.

Plot a suitable graph to determine the value for h.

h = ... [6]

(iii) Suggest **one** significant source of uncertainty in this experiment.

....

....

.... [1]

(d) LEDs are known for their efficiency in converting electrical energy to light energy output.

It is suggested that the intensity L of the light produced by an LED is related to the input power P by the following relationship:

$$P = kL^2$$

where k is a constant.

Plan an experiment to investigate the validity of this relationship.

Your account should include:

- your experimental procedure
- control of variables
- a precaution to improve the safety or reliability of the experiment.

....

....

....

....

....

....

....

....

....

....

....

.... [6]

[Total: 22]

4 A student investigates stationary sound waves in cylindrical tubes. Fig. 4.1 shows a stationary wave pattern in a tube which is open at both ends.

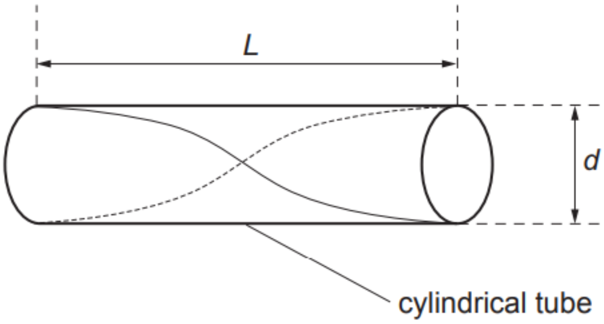


Fig. 4.1

The tube has length L and diameter d. The frequency of the sound for the stationary wave pattern shown is f.

It is suggested that the relationship between f, L and d is

$$\frac{1}{f} = kL^m d^n$$

where k, m and n are constants.

Design a laboratory experiment to determine the values of m and n.

Assume that tubes of different lengths and diameters are available.

Draw a diagram to show the arrangement of your apparatus. You should pay particular attention to:

(a) the equipment you would use
(b) the procedure to be followed
(c) the control of variables
(d) any precautions that should be taken to improve the accuracy and safety of the experiment.

Diagram

[Total: 11]

BLANK PAGE

BLANK PAGE