Catholic Junior College
JC2 Preliminary Examinations
Higher 2

CANDIDATE NAME			
CLASS	**2T**	**INDEX NUMBER**	

PHYSICS

9749/04

Paper 4 Practical

21 Aug 2023

2 hour 30 minutes

Candidates answer on the Question Paper

READ THESE INSTRUCTIONS FIRST

Write your name and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB or 2B 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 assessment, fasten all your work securely together.
The number of marks is given in brackets [ ] at end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	**/ 15**
2	**/ 6**
3	**/ 22**
4	**/ 12**
Total	**/ 55**

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1. In this experiment, you will investigate the current in an electrical circuit.

(a) You have been provided with two metre rules A and B, each with a resistance wire attached.

Take measurements to determine the resistance per unit length of each of the wires.

The resistance per unit length of the wire attached to rule A is R_A.
The resistance per unit length of the wire attached to rule B is R_B.

R_A = ……………………..………………..

R_B = ……………………..………………..

[2]

(b) Set up the circuit as shown in Fig. 1.1.

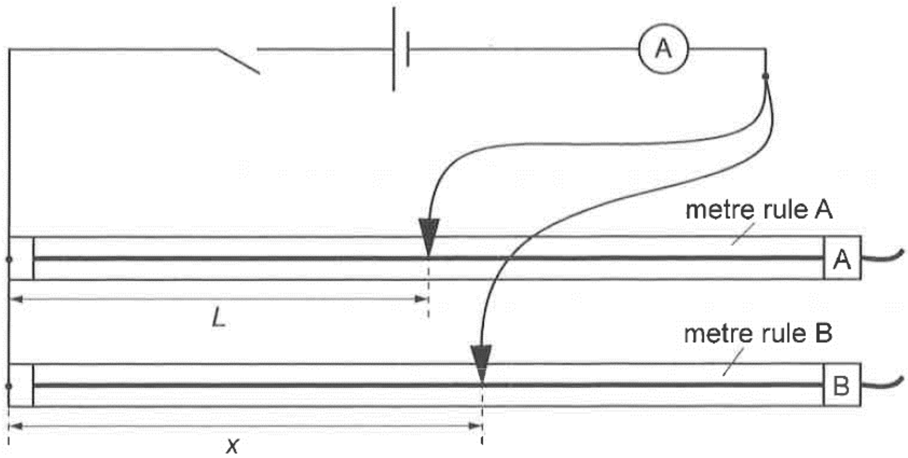

Fig. 1.1

L should be approximately half the length of the rule and *x* should be **greater** than *L*.

Close the switch.

Measure and record *L*, *x* and the ammeter reading *I*.

L = ……………………..………………..

x = ……………………..………………..

I = ……………………..………………..

[2]

(c) Vary *x,* obtaining a suitable range of values between 0 cm and 100 cm, and repeat **(b)**, keeping *L* constant throughout.

[3]

(d) It is suggested that I and *x* are related by the expression

$$I = \frac{E}{R_A L} + \frac{E}{R_B x}$$

where *E* is the electromotive force (e.m.f.) of the cell.

Plot a suitable graph to determine the value of *E*.

E = ……………………..………. V [7]

(e) Without taking further readings, sketch a line on your graph grid to show the results you would expect if the experiment was repeated with *x* measured on metre rule A and the same *L* in **1(b)** measured on metre rule B.

Label this line W. [1]

[Total: 15]

2. In this experiment, you will investigate an oscillating system.

(a) Place the wooden strip on the pivot, as shown in Fig. 2.1.

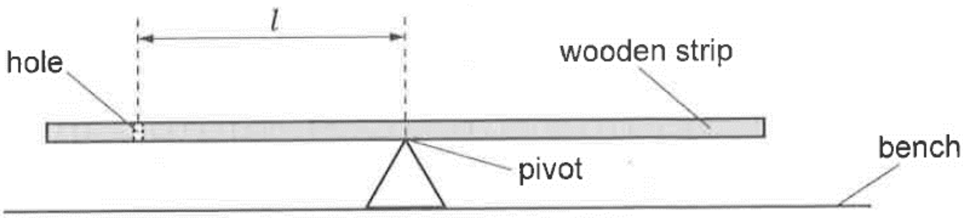

Fig. 2.1

Adjust the position of the wooden strip on the pivot until it balances. The distance between the centre of the hole in the wooden strip and the pivot is l.

Without marking on the wooden strip, measure and record l.

l = ... [1]

(b) Set up the apparatus as shown in Fig. 2.2.

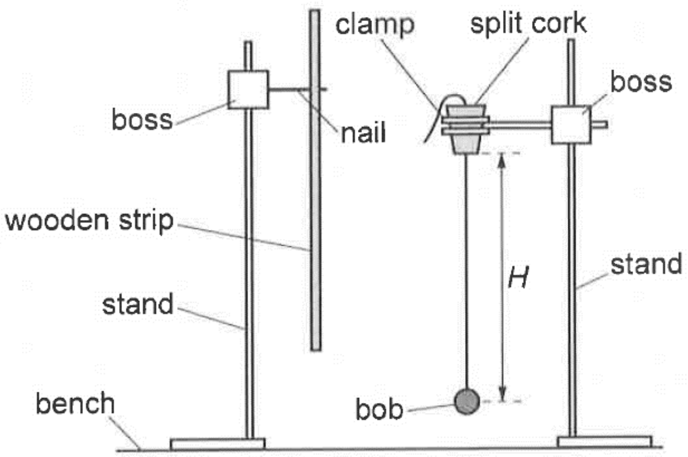

Fig. 2.2

The distance between the bottom of the split cork and the centre of the bob is H.
Adjust the string in the split cork until H is approximately 40 cm.

Displace the bob and the bottom of the wooden strip towards you through a short distance. Release the bob and the strip at the same time. The oscillations of the bob and the strip will be out of phase.

Adjust H so that the oscillations of the bob and the strip remain in phase for several cycles after release.

Measure and record H.

H = ... [1]

(c) The quantities l and H are related by the equation

$$b = \sqrt{l(H - l)}$$

where b is a constant.

(i) Calculate b.

b = ……………………..…..…….. m [2]

(ii) If you were to repeat this experiment using a similar wooden strip with several holes at different positions along its length, describe the graph that you would plot to determine b.

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……………………………………………………………………………………………..... [2]

[Total: 6]

3. In this experiment, you will investigate the stiffness of some metal wires.

A long-handled broom, as shown in Fig. 3.1, must be able to support the weight of the brush at the end without collapsing. Sometimes these brooms are used vertically to reach high places such as ceilings.

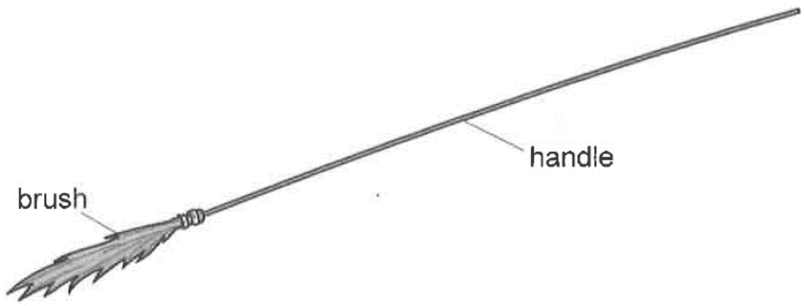

Fig. 3.1

In this experiment, you will model the broom handles using thin metal wires and investigate how the following properties of the wires affect their behaviour:

- length
- diameter
- load
- force constant.

(a) You have been provided with three wires labelled P, Q and R.

Measure and record the diameter *d* of wire P.

d = ………………….………… [1]

(b) **(i)** Attach the sphere of modelling clay to one end of wire P and hold the wire vertically between your thumb and first finger.
The length of wire between the centre of the sphere and the top of your thumb is *h*, as shown in Fig. 3.2.

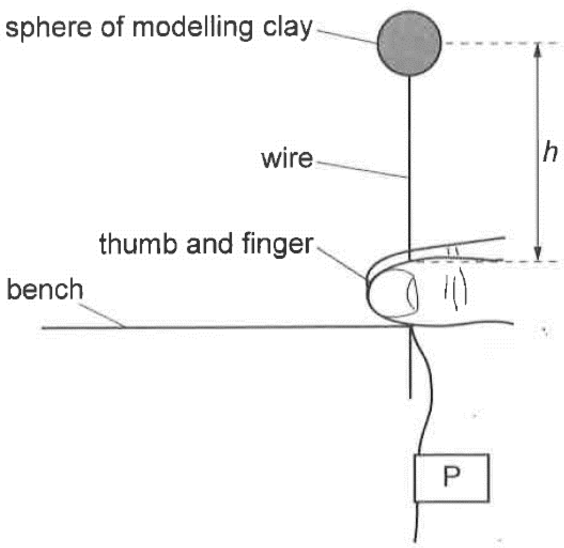

Fig. 3.2

Increase *h* until the sphere moves down and touches the bench, as shown in Fig. 3.3.

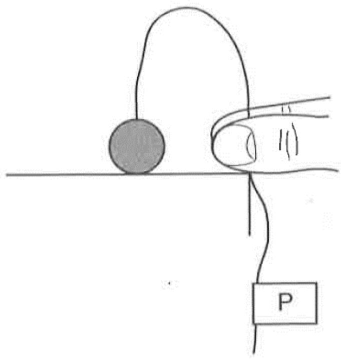

Fig. 3.3

Determine and record *h*.

h = ……………………..………. [1]

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

Percentage uncertainty in *h* = ……………………..………. [1]

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

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……………………………………………………………………………………………... [1]

(iv) Suggest an improvement that could be made to the experiment to reduce the uncertainty identified in **(b)(iii)**.

You may suggest the use of other apparatus or a different procedure.

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[Turn Over

(c) Wire Q is made from the same material as wire P, but has a different diameter.

Repeat **(a)** and **(b)(i)** for wire Q.

d = ………………………………………..

h = ………………………………………..
[3]

(d) It is suggested that

$$h = c\,d^2$$

where c is a constant.

(i) Use your values from **(a)**, **(b)(i)** and **(c)** to determine two values of c.

Give your values for c to an appropriate number of significant figures.

first value for c = ………………………………………..

second value for c = ………………………………………..
[1]

(ii) Justify the number of significant figures given to your values for c.

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(iii) State whether the results of your experiment support the suggested relationship. Justify your conclusion by referring to your answer in **(b)(ii)**.

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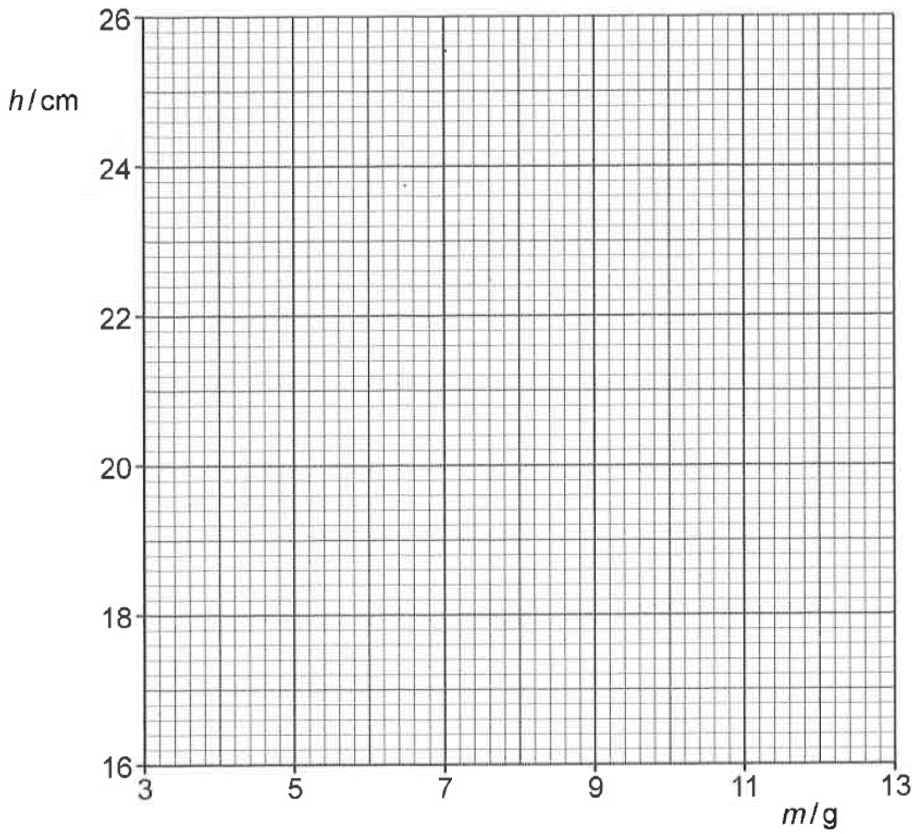
(e) In an investigation, the mass *m* of the sphere attached to the end of a wire was varied.

The following results for *m* and *h* were recorded.

m /g	4.4	6.1	8.1	9.9	11.8
h / cm	25.6	24.1	21.5	19.8	17.8

(i) Plot *h* against *m* on the grid and draw the straight line of best fit. [1]



(ii) Use your graph to determine the value *h* when no sphere is attached to the wire.

h = ……………………..……… cm [3]

[Turn Over

(f) The force constant k for a wire in tension is defined as

$$k = \frac{YA}{h}$$

where Y is the stiffness of the material of the wire and the cross-sectional area A of the wire is given by $A = \frac{\pi d^2}{4}$.

Wires P and R are made from different materials but have the **same** diameter.

Table 3.1 shows the values of Y for the two wires.

Table 3.1

	Wire P	Wire R
Y / GN m^{-2}	170	120

Take measurements to determine the value of k for each material.

Tabulate your results.

[4]

(g) The force constant *k* of wire P can be found by another method.

Plan an investigation to find *k* for a fixed length of wire P in tension using the relationship

$$F = kx$$

where *F* is the applied load and *x* is the extension of the wire.

You would be provided with several masses.

You may suggest the use of any additional apparatus commonly found in a school physics laboratory.

Your answer should include a diagram and your experimental procedure.

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[Total: 22]

4. Fig. 4.1 shows a beaker filled with water and ice cubes all at 0° C.

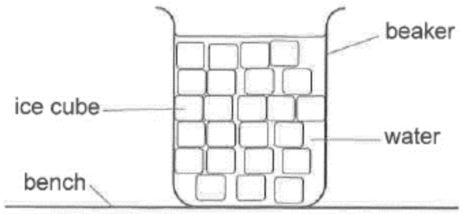

Fig. 4.1

When a constant source of heat is applied to the contents of the beaker, the ice melts.

The initial volume of each ice is the same and the number of ice cubes is n. The total mass of the contents of the beaker is m.

The time taken for the ice to melt is given by $t = k\,n^a m^b$
where k, a and b are constants.

Design an experiment to determine the values of a and b.

You are provided with trays and a freezer to produce ice cubes at 0° C.

Draw a diagram to show the arrangement of your apparatus. Pay particular attention to:

- the equipment you would use
- the procedure to be followed
- the control of variables
- any precautions that should be taken to improve the accuracy and safety of the experiment.

Diagram

[Turn Over

....[12]

[Total: 12]