NAME: ____ CLASS: _________ INDEX: __________

CATHOLIC JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATIONS

Higher 2

PHYSICS

9749/04

Paper 4: Practical

19 AUG 2022

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 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	**/ 9**
2	**/ 14**
3	**/ 21**
4	**/ 11**
Total	**/ 55**

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

1 In this experiment, you will investigate the potential difference across a current-carrying wire.

You have been provided with three wires A, B and C attached onto the respective cards.

(a) Wire A has a diameter *D*.

Without detaching the wire from the card, measure and record *D*.

D = ... [1]

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

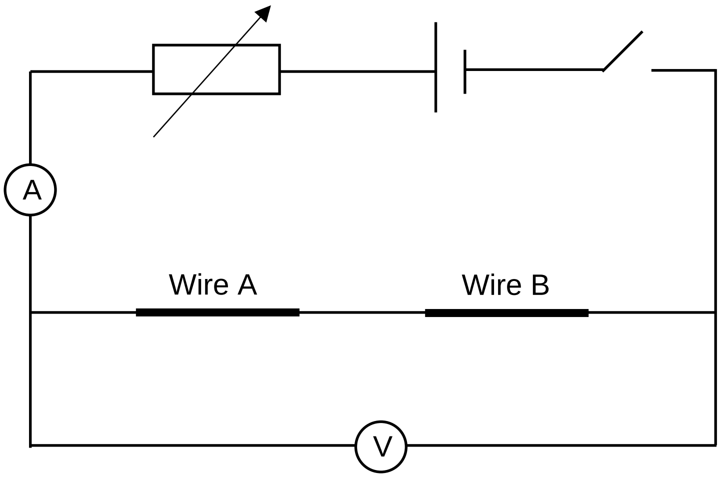

Fig. 1.1

Adjust the rheostat to approximately the middle of its range.

Close the switch.

(i) Record the ammeter reading.

ammeter reading = ... [1]

(ii) Record the voltmeter reading, *V*.

V = ... [1]

Open the switch.

(c) **(i)** Wire B has a diameter d.

Measure and record d.

d = ... [1]

(ii) The diameter D of Wire A and the diameter d of Wire B are related by G, through

$$G = \frac{D^2 + d^2}{D^2 d^2}.$$

Calculate G for Wire A and Wire B.

G = ... [1]

(d) Replace Wire B with Wire C.

Close the switch.

Adjust the rheostat so that the ammeter reading is as close as possible to the reading in **(b).**

Record the voltmeter reading V.

V = ... [1]

(e) **(i)** Wire C has a diameter d_C.

Measure and record d_C.

d_C = ...

(ii) Use the expression in **(c)(ii)** to calculate G for Wire A and Wire C.

G = ... [1]

(f) It is suggested that the relationship V and G is

$$V = kG$$

where k is a constant.

Using your data, calculate two values of k.

first value of k = ...

second value of k = ...

[1]

(g) It is suggested that the percentage uncertainty in the values of k is 4%, which is determined from the percentage uncertainties of V and G, as well as other experimental factors.

Using this uncertainty, explain whether your results support the relationship in **(f)**.

....

....

....

.... [1]

Total: [9]

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[Turn over

2 In this experiment you will investigate the equilibrium position of a half-metre rule supported by a spring.

(a) Attach the spring tied to the string and the 20 cm length of string to the half-metre rule as shown in Fig. 2.1.

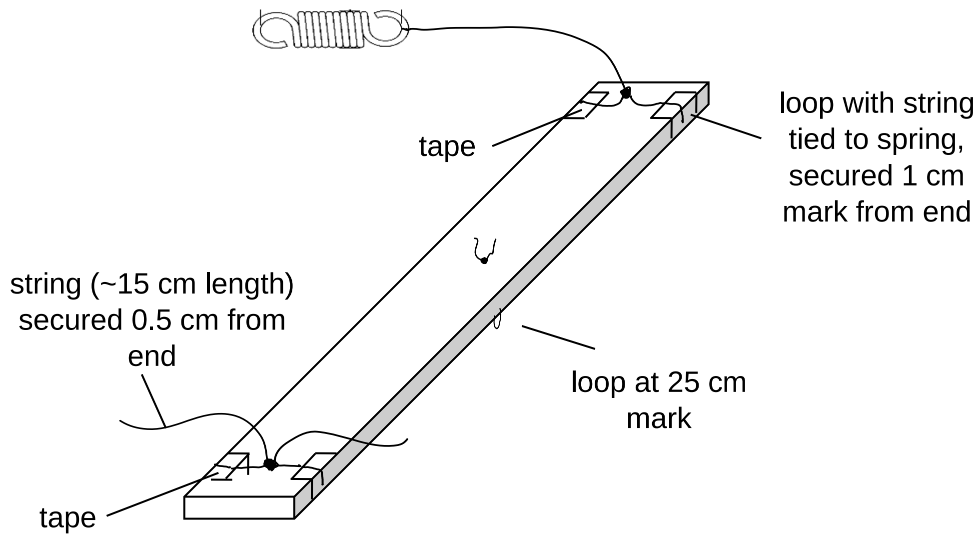

Fig. 2.1

Assemble the apparatus as shown in Fig. 2.2, using a mass *m* of 300 g.

Ensure that the mass hanger and masses are not touching the bench.

The upper string must be parallel to the bench.

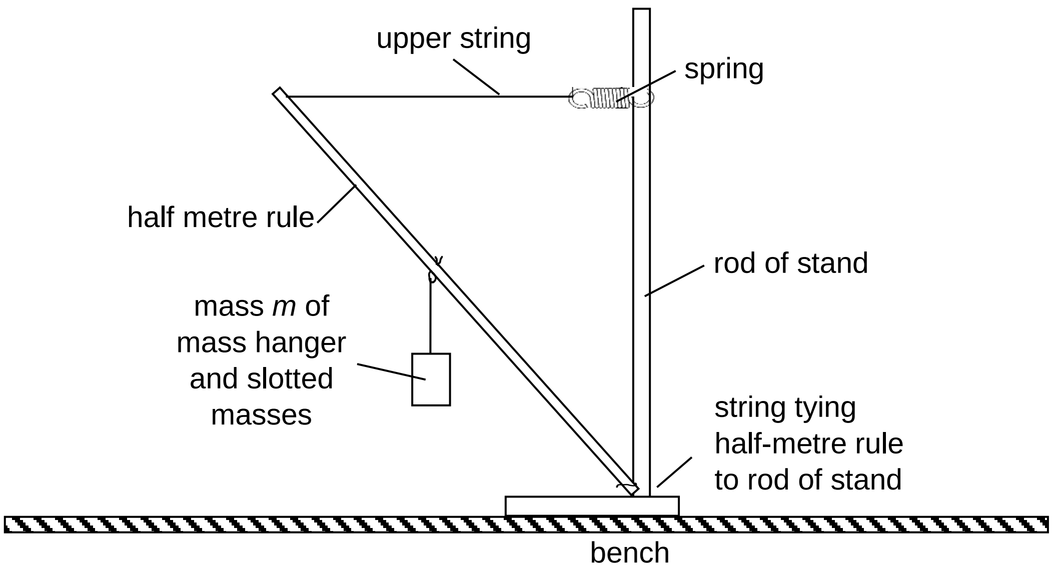

Fig. 2.2

(b) Fig. 2.3 shows the measurements you will take.

Point **A** is where the line of the upper string meets the half-metre rule.

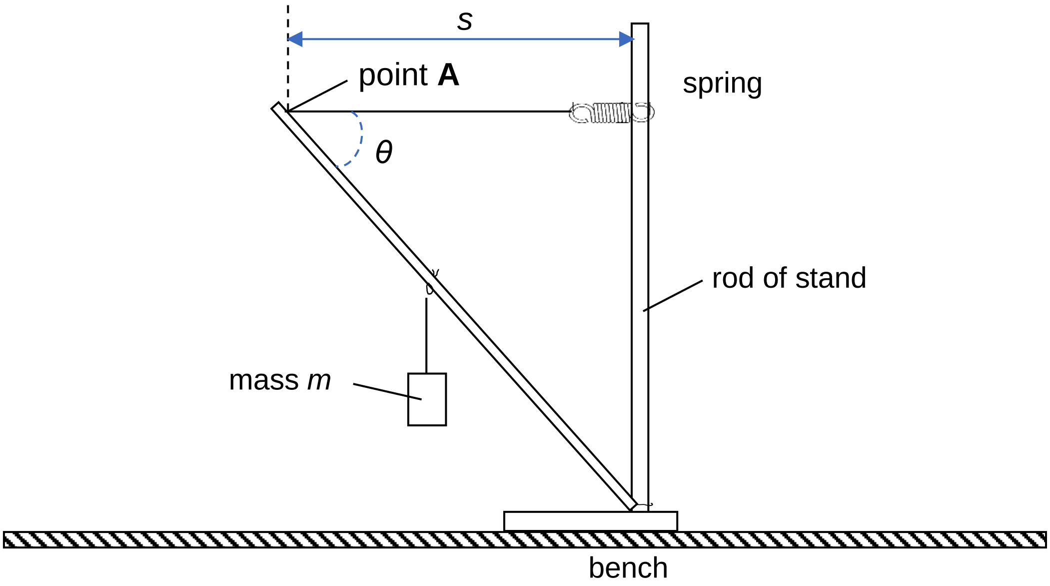

Fig. 2.3

(i) M is the mass of the half-metre rule as written on the card on the bench.

Record the value of M.

M = ...

(ii) Record the total mass m of the mass hanger and masses.

m = ...

(iii) Measure and record the distance s between the rod of the stand and **A**, as shown in Fig. 2.3.

s = ... [1]

(iv) Measure and record the angle θ, as shown in Fig. 2.3.

θ = ... [1]

(c) Change the value of m and repeat **(b)(ii)**, **(b)(iii)**, and **(b)(iv)** to obtain further sets of values of m, s, and θ.

[6]

(d) It is suggested that m, s and θ are related by the expression

$$\frac{m+M}{\tan\theta} = Ps - Q$$

where P and Q are constants.

Plot a suitable graph to determine the values of P and Q.

P = ...

Q = ...

[6]

Total [14]

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3 In this experiment, you will investigate the motion of chains of paper clips.

You are provided with two chains of 15 paper clips with two spheres of modelling clay.

(a) Measure and record the length *L* of one paper clip as shown in Fig. 3.1.

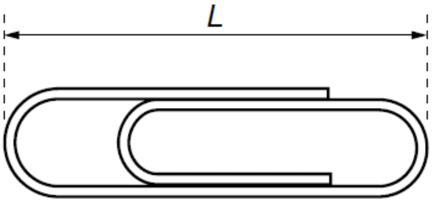

Fig. 3.1

L = ... [1]

(b) Set up the apparatus as shown in Fig. 3.2.

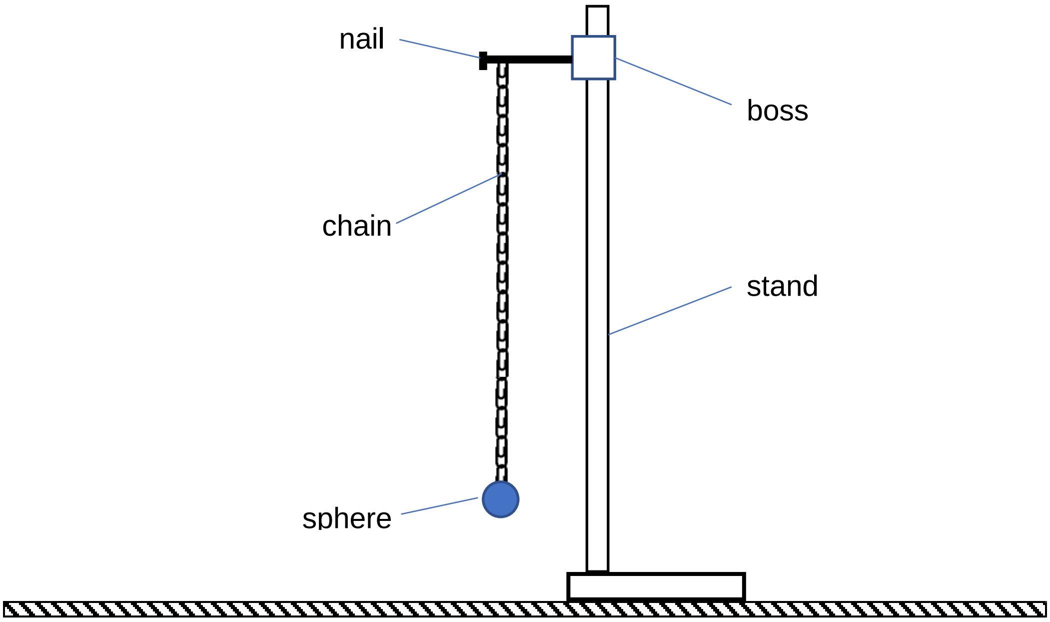

Fig. 3.2

Suspend the chain from the nail. The number *n* of the paper clips below the nail should be 15.

Move the sphere of modelling clay towards you a distance of approximately 5 cm.

Release the sphere. The chain will oscillate.

(i) Determine the period T of the oscillations.

T = ________________________________ [1]

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

percentage uncertainty of T = ________________________________ [1]

(iii) The period of the oscillations of a simple pendulum is

$$T_P = 2\pi\sqrt{\frac{l}{g}}$$

where l is the length of the pendulum.

Taking $g = 9.81\ \mathrm{m\ s^{-2}}$, calculate a value for period of the chain pendulum oscillations in Fig. 3.2.

T_P = ________________________________ [1]

(iv) Justify the number of significant figures that you have given for your value of T_P in **(b)(iii)**.

____

____

____ [1]

(v) It is suggested that the oscillation of the chain in **(b)(i)** is different from the oscillation of a simple pendulum.

State whether your results in **(b)(i)** and **(b)(iii)** support the suggestion.

Justify your conclusion by referring to your value in **(b)(ii)**.

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....

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.... [1]

(c) Set up two chain pendulums side by side as shown in Fig. 3.3.

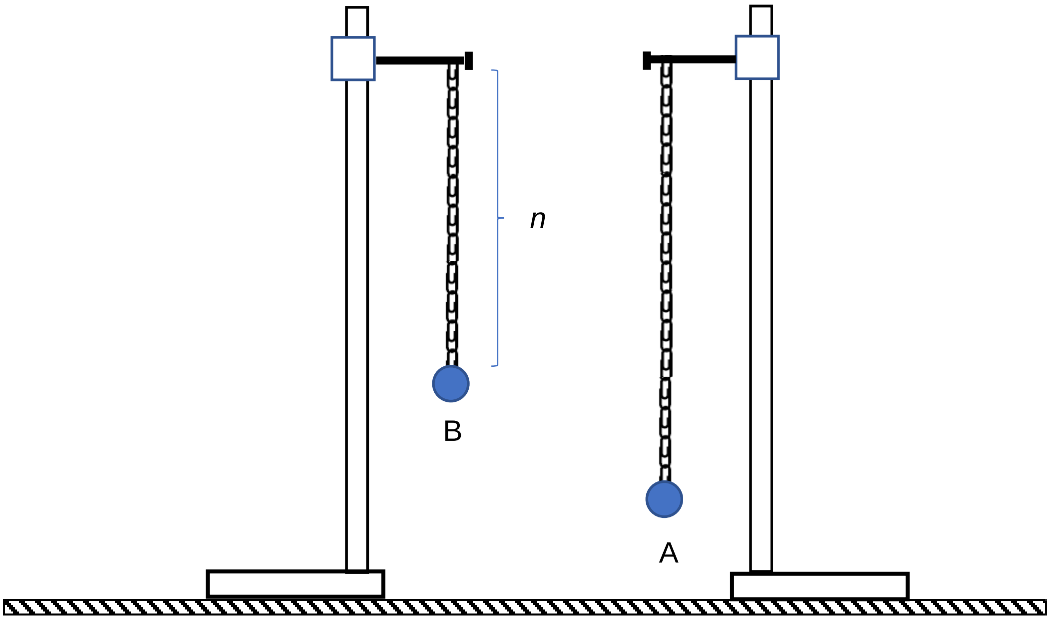

Fig. 3.3

Set chain A with 15 paper clips.

Set Chain B with n paper clips such that $n = 7$.

Record n.

n = ...

(d) Set both pendulums into motion with small oscillations.

Start the stopwatch when the two pendulums are lined up in phase.

Measure the time t taken before the next occasion when the two pendulums are in phase again.

t = ... [1]

(e) Increase the value of n and repeat **(d)** to obtain further sets of values of t until $n \leq 14$.

[3]

(f) **(i)** Plot *t* against *n* on Fig. 3.4. The graph obtained should be a curve.

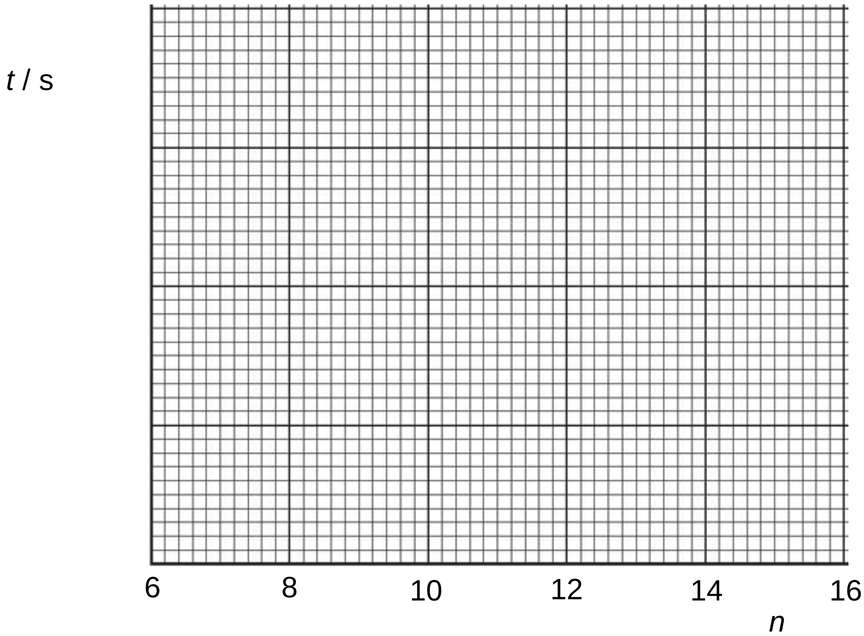

Fig. 3.4 [3]

(ii) Explain why the graph in Fig. 3.4 does not have a *t* value at $n = 15$.

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.... [2]

(g) **(i)** Theory suggests that

$$t = A\frac{\sqrt{Cn}}{\sqrt{C}-\sqrt{n}}$$

where A and C are constants.

State the graph to plot to obtain a straight line to determine values for constants A and C, assuming that the theory is correct.

____

____ [1]

(ii) State expressions for the gradient and y-intercept of the straight line.

gradient = ______________________________

y-intercept = ______________________________ [1]

(h) The physics of the oscillations of a hanging chain without the spherical modelling clay as shown in Fig. 3.5 is studied by Daniel Bernoulli in 1732, which led to the introduction of Bessel Functions.

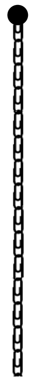

Fig. 3.5

It was theorised that the period T of the oscillations depends on the mass per unit length, which is known as the linear mass density ρ of the chain.

Explain how you would investigate the relationship between the period T of the oscillations and the linear mass density of the chain.

Your account should include:

- your experimental procedure
- control of variables
- how you would determine the linear mass density ρ of the chain
- how you would use your results to deduce the relationship of T and ρ.

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[4]

Total [21]

4 Gases can absorb light of certain wavelengths as observed in the absorption line spectra.

A substance that consists of atoms and molecules may dissolve in water to form a solution which is also observed to absorb light of certain wavelengths.

The amount of light of a particular wavelength after passing through such a solution depends on the concentration c of the substance in water. The concentration c is defined as the mass of substance dissolved in per unit volume of water.

The intensity I detected from a light source of a particular wavelength after the absorption by the solution is given by the equation

$$I = kc^nL^m$$

where k, n and m are constants. L is the path length that the light takes to pass through the solution.

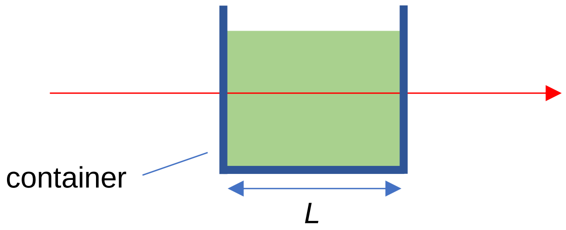

Fig. 4.1

Design an experiment to determine the values of n and m.

You are provided with containers of different sizes and a monochromatic laser light source. You also provided with the substance to be dissolved in water and the solution absorbs the laser light provided.

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)** how the concentration of the solution and the path lengths are measured
- **(d)** the control of variables
- **(e)** any precautions that should be taken to improve the accuracy and safety of the experiment.

Diagram

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[11]

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