Catholic Junior College
JC2 Preliminary Examinations
Higher 2

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

PHYSICS **9749/04**

Paper 4 Practical **19 August 2024**

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	**/ 23**
4	**/ 11**
Total	**/ 55**

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

(a) *Y*ou have been provided with two identical metre rules, A and B.

Set up the circuit shown in Fig. 1.1.

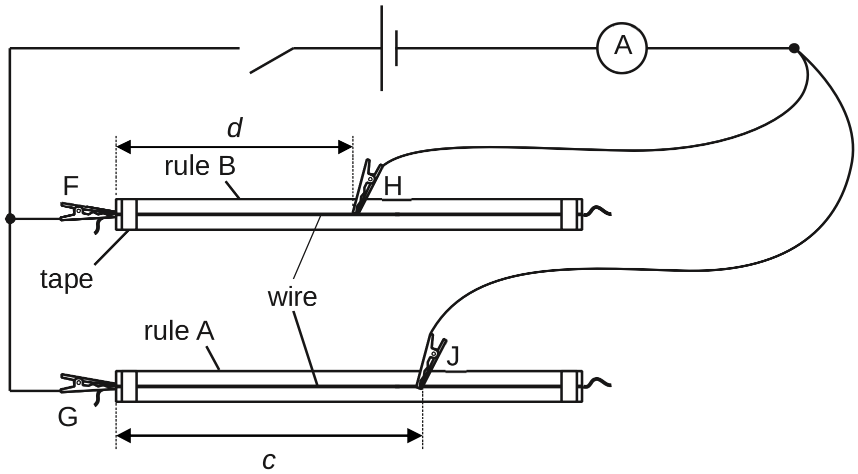

Fig. 1.1

F, G, H and J are crocodile clips of the connecting leads.

(i) Place H approximately half-way along the wire on rule B. The distance between F and H is *d*, as shown in Fig. 1.1.

Place J on the wire on rule A so that the distance between G and J is approximately 60 cm. The distance between G and J is *c*, as shown in Fig. 1.1.

Record *d* and *c*.

d = ……………………………………………

c = ……………………………………………
[1]

(ii) Calculate *n*, where $n = \dfrac{c - d}{d}$.

n = ……………………………………………

(iii) Close the switch.

Record the ammeter reading I.

I = ………………………………………… [1]

(iv) Open the switch.

(b) Vary *c* such that *c* is greater than *d* and repeat **(a)(iii)**, keeping *d* constant throughout.

Present your results clearly.

[5]

(c) It is suggested that I and n are related by the expression

$$I = S\frac{(n+2)}{(n+1)} + T$$

where S and T are constants.

Plot a suitable graph to determine the values of S and T.

S = ……………………………………………

T = ……………………………………………

[7]

(d) Theory suggests that S is inversely proportional to d and that T is independent of d. The experiment is repeated using the same equipment but a larger value of d.

For this experiment, draw a second line on the graph to show the expected results. Label this line W. [1]

[Total: 15]

2. In this experiment, you will investigate the extension of a spring.

(a) You have been provided with a spring.
Measure and record the length x_0 of the unstretched spring, as shown in Fig. 2.1.

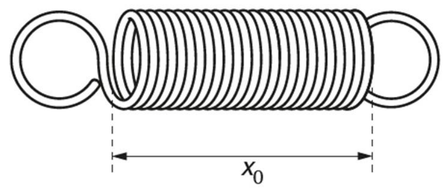

Fig. 2.1

x_0 = ……………………………………………

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

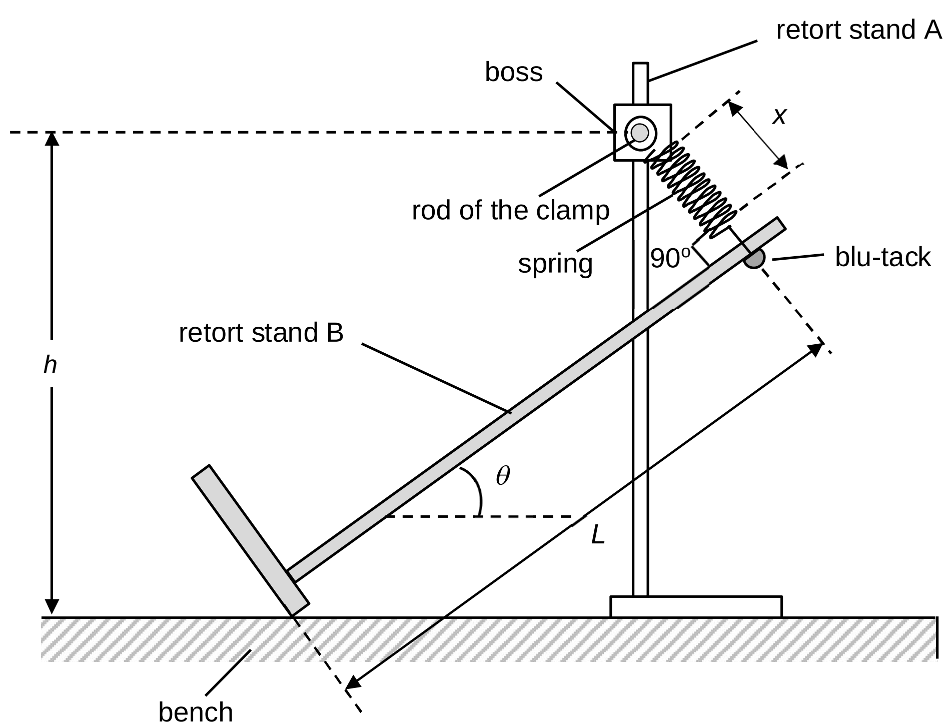

Fig. 2.2

The height h of the rod of the clamp above the bench should be approximately 38 cm.

One loop of the spring should be around the rod of the clamp.

The other loop of the spring should be around the rod of retort stand B close to the top of the rod of retort stand B and secured using blu-tack.

(c) Slide the base of retort stand B until the angle between the rod of retort stand B and the stretched spring is 90°.

The length of the coiled section of the spring is x.
The angle between the rod of retort stand B and the horizontal is θ.
The length between the base of the retort stand B and the spring is L.

Measure and record x, θ and L.

x = ...

θ = ...

L = ...
[2]

(d) Calculate e where $e = x - x_0$.

e = ... [1]

(e) Reduce the height h of the rod of the clamp to approximately 32 cm. Keeping L constant, slide the base of retort stand B until the angle between the rod of retort stand B and the stretched spring is again 90°.

Measure and record x and θ. Calculate e.

x = ...

θ = ...

e = ...

(f) Theory suggests that the quantities e and θ are related by the equation

$$e + \frac{mp}{L}\tan\theta\cos\theta = \frac{mq}{L}\cos\theta$$

where m is the mass of retort stand B, $p = 0.246\ \text{cm}^2\ \text{g}^{-1}$ and $q = 0.369\ \text{cm}^2\ \text{g}^{-1}$.

It is also found that the force constant of the spring k is given by the equation

$$k = \frac{gy}{p}$$

where $g = 9.81\ \text{m s}^{-2}$ and $y = 4.2$ cm.

(i) Calculate k.

k = ………………………………… N m^{-1} [1]

(ii) If you were to repeat this experiment with other values of θ, describe the graph that you would plot to determine k.

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[Total: 6]

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3. In this experiment, you will investigate the motion of a hacksaw blade supported by a G-clamp.

(a) Using the blu-tack, attach the two slotted masses as close as possible to one end of the hacksaw blade, as shown in Fig. 3.1.

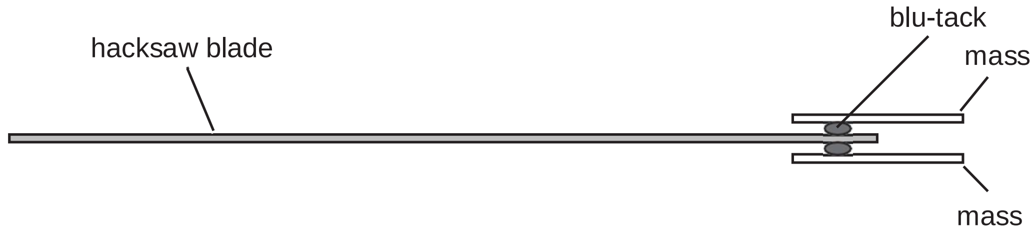

Fig. 3.1

(b) (i) Using a micrometer screw gauge, measure the thickness u of the hacksaw blade.

u = ………………………………………… [1]

(ii) Using a vernier caliper, measure the breadth w of the hacksaw blade.

w = ………………………………………… [1]

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

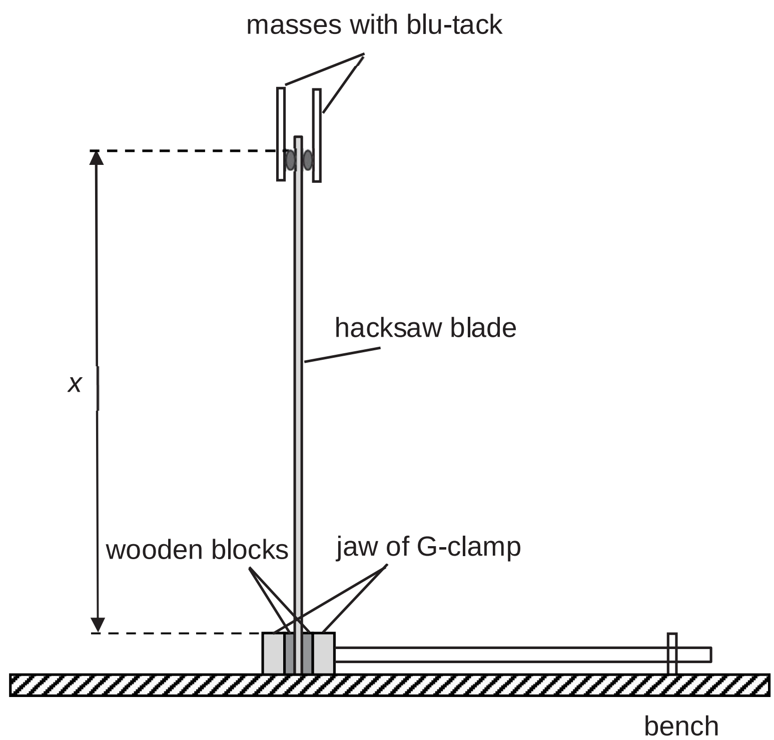

Fig. 3.2

(ii) Measure and record the distance x between the top of the jaw of the G-clamp and the centre of the masses, as shown in Fig. 3.2.

x = ... [1]

(iii) Estimate the percentage uncertainty in your value of x.

percentage uncertainty = ... [2]

(d) **(i)** Gently displace the top end of the hacksaw blade to the left. Release the blade and watch the movement.

The blade will move to the right and back towards the left, completing a swing as shown in Fig. 3.3.

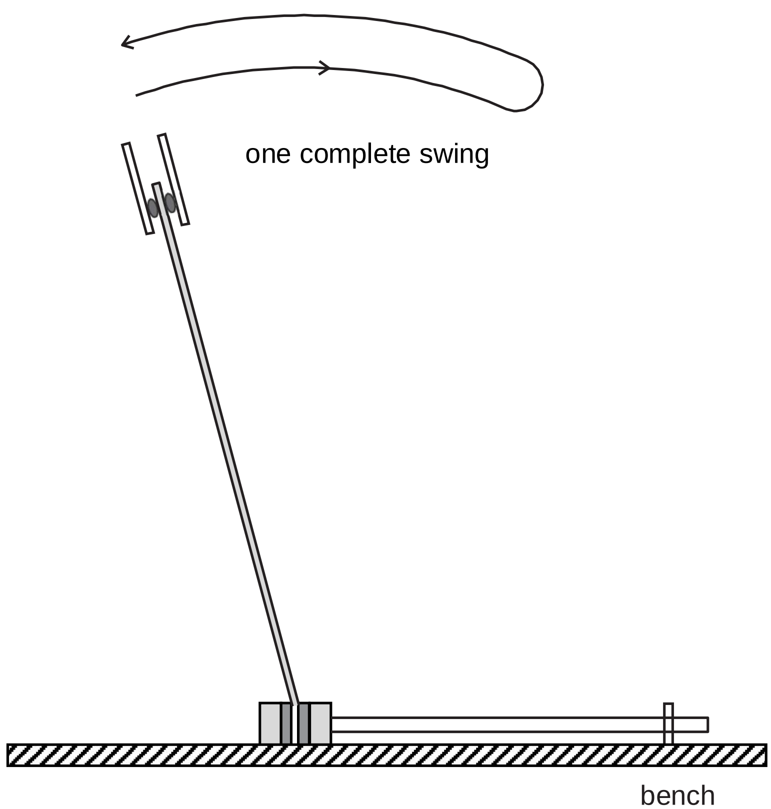

Fig. 3.3

(ii) The time taken for one complete swing is *T*.

Take measurements to obtain an accurate value for *T*.

T = ... [3]

(iii) Calculate the frequency *f* of the swings.

f = ... [1]

(e) **(i)** Reduce *x* by attaching the masses to another position on the hacksaw blade.

(ii) Repeat **(c)(ii)** and **(d)**.

x = ...

T = ...

f = ...

[2]

(f) It is suggested that the relationship between f and x is

$$f^2 = \frac{k}{x^3}$$

where k is a constant.

(i) Using your data, calculate two values of k.

first value of k = ……………………………………………

second value of k = ……………………………………………
[2]

(ii) Justify the number of significant figures that you have given for your value of k.

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……………………………………………………………………………………………………

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

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

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

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(ii) Suggest an improvement that could be made to the experiment to reduce the uncertainty identified in **(g)(i)**.

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

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(h) Fig. 3.4 shows a metronome.

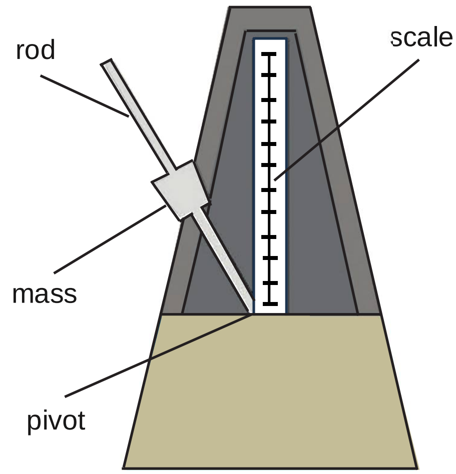

Fig. 3.4

A metronome is a device used by musicians to set a regular beat in which a rod moves backwards and forwards. The rod must be displaced sideways before it starts to move.

The frequency *f* of the beat of the rod is adjusted by moving a mass along the length *x* of the rod. The position of the mass on the rod determines the frequency of the beat. The position of the mass can be measured on the scale of the metronome.

Most music is within the range 60 to 200 beats per minute.

A manufacturer wishes to keep the length of the rod of the metronome to 8 cm. The mass on it can be moved between 2 cm to 8 cm from the pivot.

The hacksaw blade, clamped vertically at the bottom end, can be used to model the rod of a metronome.

Plan an investigation to determine the relationship between the length *x* of the rod and frequency *f* of a beat that can be used to calibrate the metronome.

Your account should include:

- your experiment procedure,
- control variables,
- how you would determine a suitable mass to use as the movable mass,
- how you would determine the relationship between length *x* and frequency *f*.

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.... [6]

[Total: 23]

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4. Fig. 4.1 shows a metal plate placed above a heater of constant power.

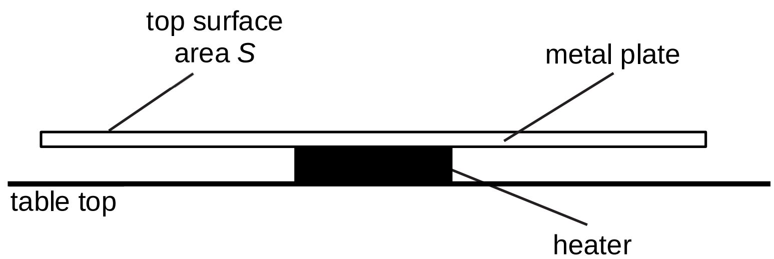

Fig. 4.1

After the metal plate is heated for some time, it reaches an equilibrium temperature θ.

The metal plate is rectangular in shape and has a top surface area S. The metal plate has steady wind flow above it with wind speed v.

Theory suggests that the equilibrium temperature is given by

$$\theta = kS^a v^b$$

where k, a and b are constants.

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

You are provided with rectangular metal plates of different surface areas.

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

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[11]

[Total: 11]

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