ST JOSEPH'S INSTITUTION
PRELIMINARY EXAM 2022
(YEAR 4)

CANDIDATE NAME			
CLASS		INDEX NUMBER	

Physics
Paper 3

6091/03

22 August 2022
1 hour 50 minutes

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number at the top of this page and all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the Question Booklet.

You will be allowed to work with the apparatus for a maximum of **55 minutes for each section**.

You are expected to record all your observations as soon as they are made.

The use of an approved scientific calculator is expected, where appropriate.

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	
2	
3	
Total	**/ 40**

This document consists of **13** printed pages including this cover page

Section A

1 In this experiment, you will determine the period of oscillation of a suspended rule.

You are provided with
- a 30 cm rule
- a half metre rule
- a metre rule
- two retort stands
- a stopwatch

The apparatus in Fig. 1.1 has already been set up for you.

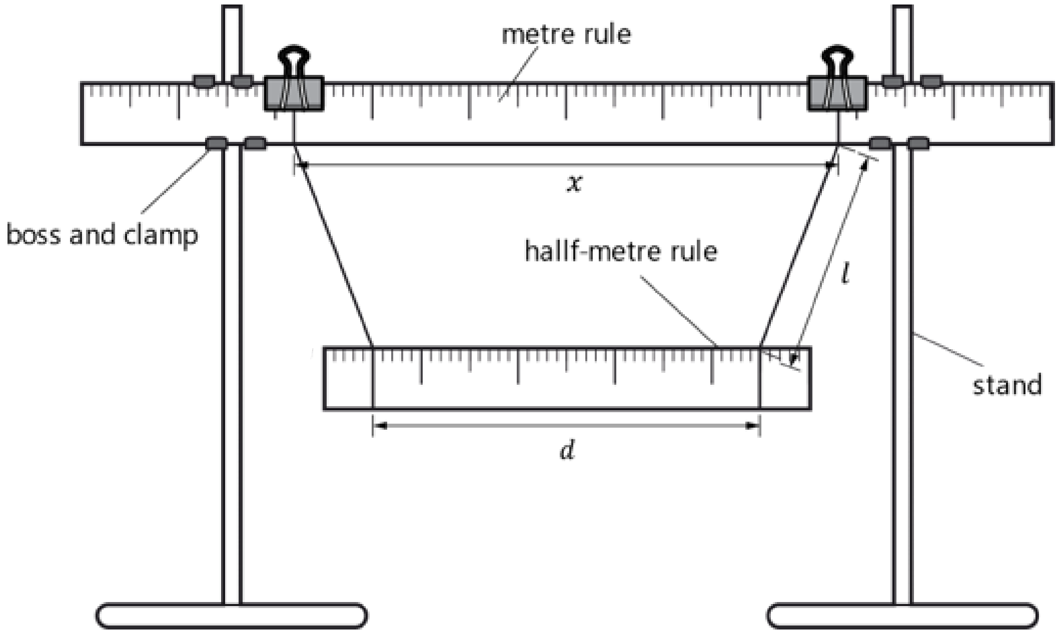


Fig. 1.1

(a) The metre rule has been adjusted horizontally for you. Describe the process needed to check that the half-meter rule is parallel to the metre rule.

Use another metre rule to measure the vertical/perpendicular distance between the two ends of the half-metre rule to the metre rule. If the distances are the same, the two rules are parallel.

....[1]

(b) **(i)** Measure the length *l* along the thread that connect the two rules as shown in Fig. 1.1.

l is measured to the correct precision of metre rule: 0.001 m = 0.1 cm

l is within range (19.0 – 22.0)

length l = ... [1]

(ii) Explain one difficulty in obtaining an accurate value for l.

....

.... [1]

- The ruler/the thread keeps on moving/shaking as it is suspended in the air, hence l is an estimation.
- The thread may extend as it is being measured.

(iii) Measure *d*, the distance between the two loops on the lower rule.

d is measured to the correct precision of metre rule: 0.001 m = 0.1 cm

d is within range (39.0 – 41.0 cm)

distance *d* = ... [1]

(c) **(i)** By using the clips, adjust the threads until x, the distance between the loops on the upper rule, is 0.400 m.

(ii) Rotate one end of the lower rule towards you and the other end away from you, each by the same small angle so that the middle of the rule does not move. Release the rule so that it oscillates freely about the vertical axis.

(iii) In one complete oscillation, each end of the rule moves from one side to the other and back again. Determine a value for the period *T* of the oscillating rod.

Time taken **for 5-10** oscillations is done at least two times and average is taken.

t_1 =3.4 s
t_2 =3.5 s
t_{ave} = 3.5 s (1dp, 2sf)

T= t_{ave} /5 = 0.70 s (2 sf)
Within acceptable range (0.63 s to 0.77s)
When t is measured to the correct precision: t=0.1 s (1dp), the answer should be in 2sf.

T = ... [2]

(d) It is suggested that *T* and *d* are related by the equation

$$T = \frac{4\pi}{d}$$

where *d* is measured in cm.

(i) Calculate the value of *T* according to the suggested equation.

Correct calculation of *T* with the correct significant figures
Calculated to 2/3sf. (allow ecf of sf from biii)

***d*/cm**	***T*/s**
39.0	0.322
39.5	0.318
40.0	0.314
40.5	0.310
41.0	0.306

T = ………………………………. [2]

(ii) Explain whether your values of T in **(c)(iii)** and **d(i)** support this suggestion.

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………[2]

- No, it did not support the suggestion.
- The two T values are very different, the percentage (%) error between the two values **is more than 10%.**

Yes, it support the suggestion
□ The T theoretical and practical are the same, <u>or</u>
□The two Ts are very close, the percentage (%) error between the two values **is less or equal to 10%.** Considering possible experimental errors in determining the two values, the two Ts can be considered as equal.

[Total: 10]

2 In this experiment, you will investigate the frictional force opposing the motion of a block of wood on which masses have been added.

You have been provided with

- a newton meter
- a wooden block
- five 100 g masses
- a protractor
- an electronic balance

(a) Place a load of five 100 g masses on top of the wooden block. Pull the block horizontally across the bench at constant speed by means of the newton-meter, as shown in **Fig. 2.1**.

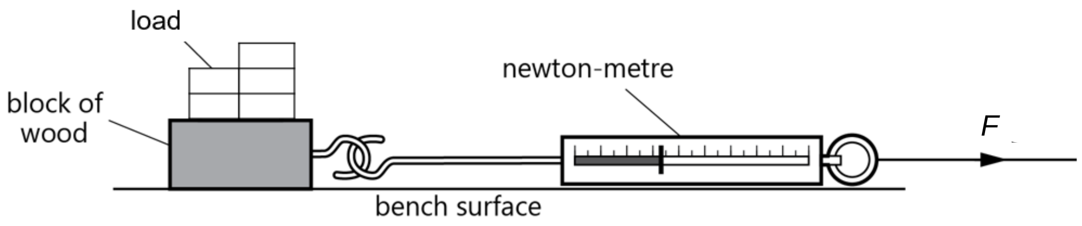


Fig. 2.1

(i) Using the newton-metre, determine an average value for the force F required to move the block and the masses across the bench at constant speed.

F is measured to the correct precision of spring balance. (p= 0.2 N) and in correct unit.

No range is given (eg. 3.2N)

F =…………………………………….. [1]

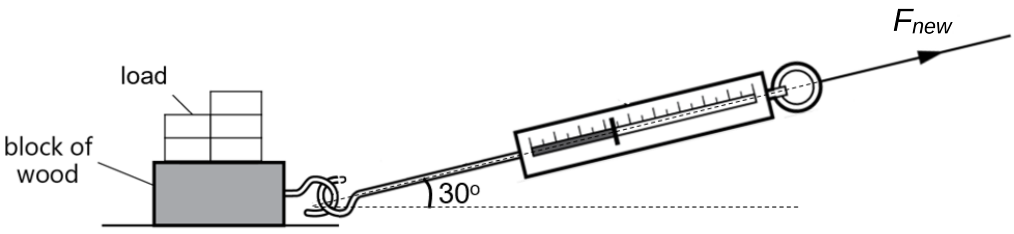
(ii) Measure and record the total mass M_{total} of the block with the added masses used in **(a)**.

M_{total} =………………………………….. [1]

M_{total} is measured to the correct precision of electronic balance. (p= 0.1 g) and in correct unit.

M_{total} = 618.7 g
Acceptable range (612.0 g – 624.0 g)

(b) **(i)** Rotate the newton-metre such that it forms a 30 ° angle to the horizontal as shown in Fig. 2.2.



(ii) Maintain this angle and pull the block such that it moves horizontally across the bench at constant speed again.

Using the newton-metre, determine an average value for the new force F_{new} required to move the block and the masses across the bench at constant speed.

F is measured to 0.2 N.
(no checking on the range of F_{new}, but F_{new} **it must be smaller than F in a(i)** if measured accurately**)**

Eg. F_{new} =2.8 N

F_{new} =…………………………………….. [1]

(iii) State one significant source of error in this experiment.

………………………………………………………………………………………..

………………………………………………………………………………………[1]

- It is difficult to maintain a constant angle of inclination/constant force/constant speed while pulling the block horizontally.
- The spring balance may accidentally touched the bench, creating additional friction

Hence the value of F_{new} is an estimate.

(c) Coefficient of friction, μ is the ratio of the frictional force resisting the motion of two surfaces in contact to the normal force pressing the two surfaces together.

When the pulling force on the wooden block is horizontal as in **(a)**, μ can be calculated as

$$\mu = \frac{F}{W_{total}}$$

Where W_{total} is the total weight of the block and the load and the gravitational field strength is 10 N/kg.

It is expected that the value of μ between the block and the bench is a constant.

Plan an experiment to determine the value of μ.

Your plan should include
- a quantity that you should keep constant
- a detailed description of how you will perform the investigation
- an indication of how you ensure accurate readings
- a statement and a sketch of the graph that you expect to obtain
- an explanation of how you would obtain the value of μ from your graph.

[6]

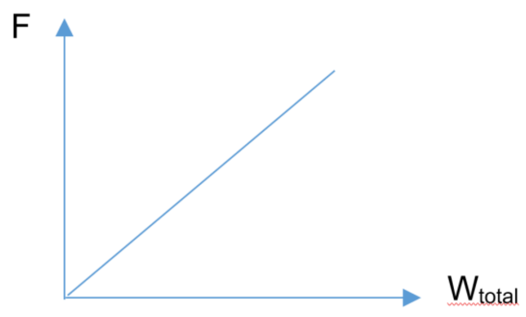
Constant (only 1)
- The block used
- The surface of the block that is in contact with the bench
- The direction of Newton meter (horizontal) / angle

Independent variable: the mass of the load
Measure the Mtotal & calculate the Wtotal
Dependent variable: the pulling Force applied
Repeat the step to determine the force twice and calculate the average F

Tabulate the following:

M_{total}/g	W_{total}/N	F/N

Plot a graph of F against W_{total}



The graph is a straight line that passes through the origin, and μ is the gradient of the graph.

[Total: 10]

Section B

3 In this experiment, you will investigate the resistivity of wires used in an electrical circuit.

You are provided with:

- two wires mounted on identical wooden strips labelled A and B
- a micrometer screw gauge
- an ammeter
- two dry cells of emf 1.5 V each
- a switch
- leads and crocodile clips
- a metre rule

(a) You have been provided with two identical wooden strips labelled A and B.

(i) Measure and record the length *L*, in m, of the wire between points X and Y on strip B, as shown in Fig. 3.1.

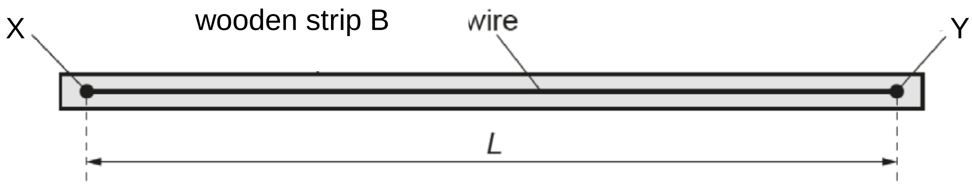


Fig. 3.1

0.700 m

L = ... [1]

(ii) Measure the diameter *d* of the wire mounted on B.

Zero error = -0.01 mm

½ (0.36+0.37) = 0.37 mm **(2 sf)**

d = ... [1]

(iii) Calculate the cross sectional area *A* of the wire mounted on B in m^2.

$$\pi\left(\frac{0.37}{2000}\right)^2 = 1.1\times10^{-7}\,\mathrm{m}^2$$

A =.......................... [1]

(b) Set up the circuit shown in Fig. 3.2. Attach crocodile clip G to the wire on wooden strip A so that the distance *x* from the left of strip A to G is approximately 30 cm, as shown in Fig. 3.2.

Attach crocodile clip H to the wire on wooden strip B so that it is the same distance *x* from the left end of strip B to H.

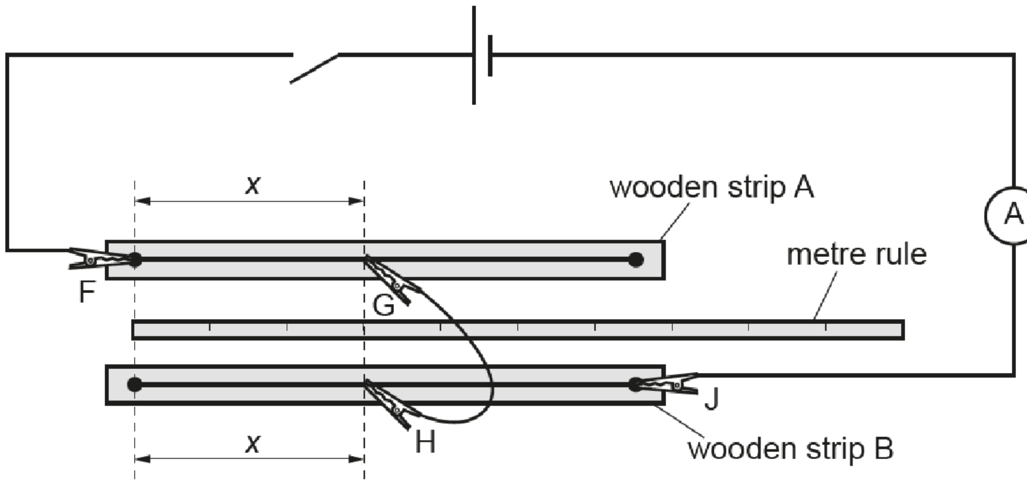


Fig. 3.2

Close the switch.

(i) Record *x* and the ammeter reading *I*.

x = ... *30.0 cm*

I = ... *0.31 A* [1]

(ii) Explain why the potential difference *V* across F and J is 3.0 V.

F and J are connected to the positive and negative terminals of the 1.5 V dry cell therefore they measure the emf of the dry cell.

OR

The sum of the pd across FG and FJ which are in series is the emf of the dry cell

....

.... [1]

Open the switch.

(c) Vary *x* and repeat **(b)** until you have 6 sets of readings of *x* and I for values of *x* between 20.0 cm to 65.0 cm. Include your values from **(b)(i)**. Record your results in a table. Include values of $\frac{1}{I}$ in your table.

[4]

x/cm	*I/A*	*1/I/(1/A)*
20.0	*0.32*	*3.1*
30.0	*0.31*	*3.2*
35.0	*0.30*	*3.3*
40.0	*0.30*	*3.3*
45.0	*0.29*	*3.5*
50.0	*0.28*	*3.6*
55.0	*0.28*	*3.6*
60.0	*0.27*	*3.7*
65.0	*0.26*	*3.9*

1 – header, 1 – range and precision of x, 1 – 0.01 A, 1 – 2sf (1/I)

(d) **(i)** Using the grid provided on page 13, plot a graph of $\frac{1}{I}$ against *x*.

Draw the line of best fit. [4]

Axis, Scale, Points, Best Fit Line

(ii) Determine the gradient of the line of best fit and y-intercept of this line.

Gradient $= \frac{3.750-3.230}{60.0-30.0} = 0.0173 \text{ or } 0.017$

1 – coordinates, 1 – precision, 1 – range, sf

Using y = mx + c

3.230 = 0.0173(30.0) + c

c = 2.710 ***(1 – correct dp based on scale)***

gradient = …………………….. [3]

y-intercept = ……………………[1]

(e) The quantities I and *x* are related by the equation

$$\frac{1}{\square} = \frac{x}{k}(\rho_A - \rho_B) + \frac{\rho_B L}{AV}$$

where

- ρ_A and ρ_B are the resistivity of the wires mounted on wooden strip A and B respectively,
- *A* is the cross sectional area of wire B,
- *V* is the emf,
- k is a constant.
- *L* is the length of the wire mounted on wooden strip B

Determine ρ_B the value of the resistivity of wire B.

y intercept $= \frac{\rho_B L}{AV} = 2.710$

$$\rho_B = (2.710 \times 1.1 \times 10^{-7} \times 3.0) \div 0.700 = 1.3 \times 10^{-6} \Omega m$$

ρ_B = ……………………. [2]

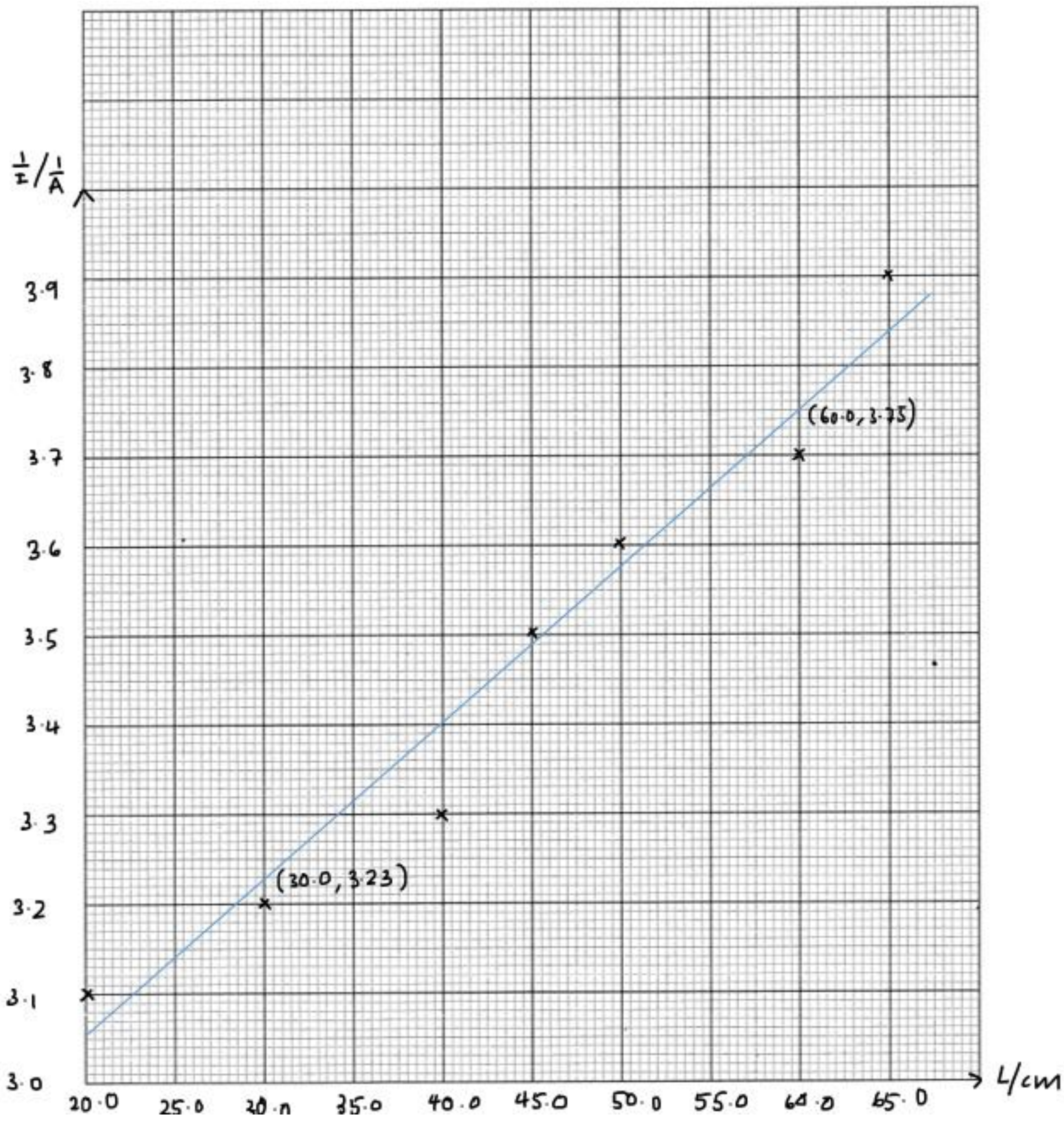
(f) Explain a source of error that caused the value of ρ_B to be inaccurate.
Kinks in wire/crocodile clip used instead of jockey – length L is not accurate

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………..

[1]



[Total 20]

~ **END OF PAPER** ~