TAMPINES MERIDIAN JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION

CANDIDATE NAME	
CIVICS GROUP	

H2 Physics **9749/04**

Paper 4 Practical **24 August 2023**

2 hours 30 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces at the top of this page, page **9** and **17**.
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.

You are allowed 1 hour to answer Questions 1 and 2; and you are allowed another 1 hour to answer Question 3.

Question 4 is a question on the planning of an investigation and does not require apparatus.

Write your answers in the space provided in 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.

The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	**/15**
2	**/7**
3	**/21**
4	**/12**
Total	**/55**

1 In this experiment you will be required to investigate the use of a combination of resistors in circuit analysis.

Set up the apparatus as shown in Fig. 1.1. Resistor *R* represents the combined resistance of one to three 10.0 Ω resistors connected in parallel, series or a combination.

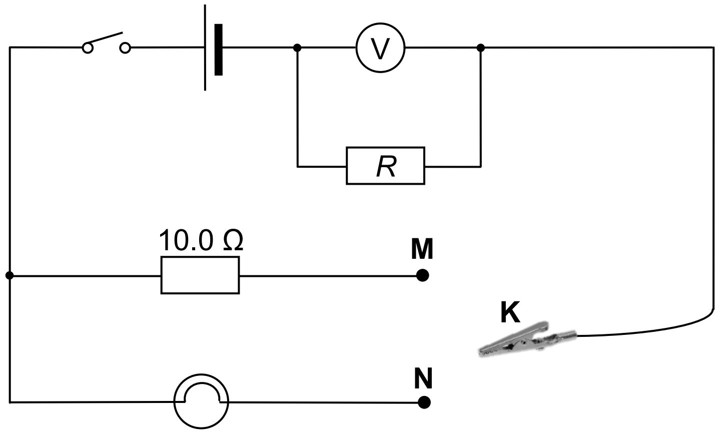

Fig. 1.1

(a) **(i)** Set *R* to be 10.0 Ω.

(ii) Attach the crocodile clip **K** to **M**.

Close the switch and record the voltmeter reading V_M.

V_M = ………………………

(iii) Open the switch. Attach the crocodile clip **K** to **N**.

Close the switch and record the voltmeter reading V_N.

V_N = ……………………[1]

(iv) Calculate the value of $\frac{1}{V_M} - \frac{1}{V_N}$.

$\frac{1}{V_M} - \frac{1}{V_N}$ = …………………………

(v) Repeat steps **(a)(ii)** to **(a)(iii)** to obtain further sets of readings for V_M and V_N by varying R.

[5]

(b) Theory suggests that V_M, V_N and R are related by the expression

$$\frac{1}{V_M} - \frac{1}{V_N} = \frac{B}{R} + C$$

where B and C are constants.

Plot a suitable graph to determine B and C.

B = ……………………….

C = ………………………. [4]

[3]

(c) By making suitable calculations, determine whether $V_M = V_N$ can be achieved for this setup.

…………………………………………………………………………………………………….

…………………………………………………………………………………………………….

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

[Total: 15]

2 This experiment considers the forces on a wooden cylinder.

(a) You have been provided with a wooden cylinder with a spring attached.

The distance *L* between the centre of the hole at one end of the cylinder and the other end of the cylinder is shown in Fig. 2.1.

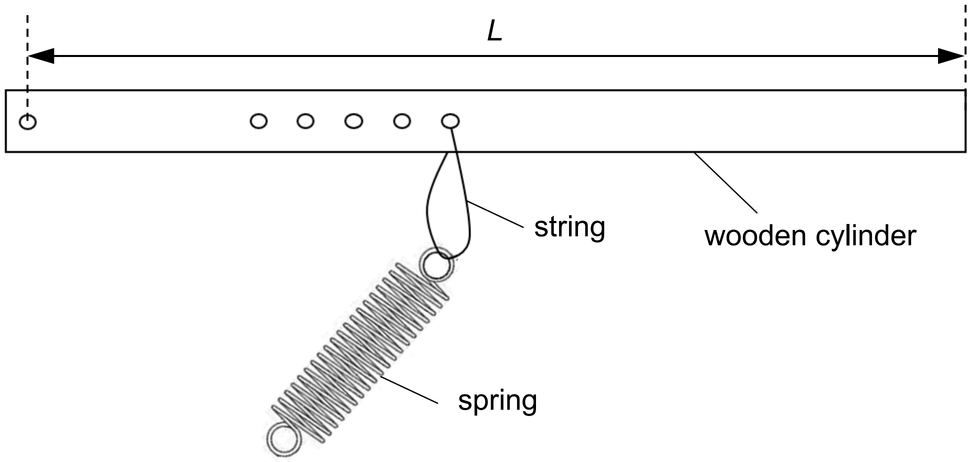

Fig. 2.1

The length of the unstretched spring is *S*, as shown in Fig. 2.2.

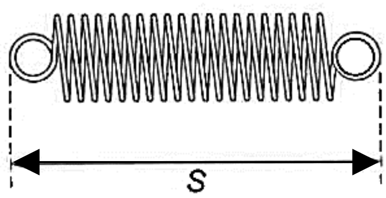

Fig. 2.2

Measure and record *L* and *S*.

L = ...

S = ... [1]

(b) Set up the apparatus as shown in Fig. 2.3.

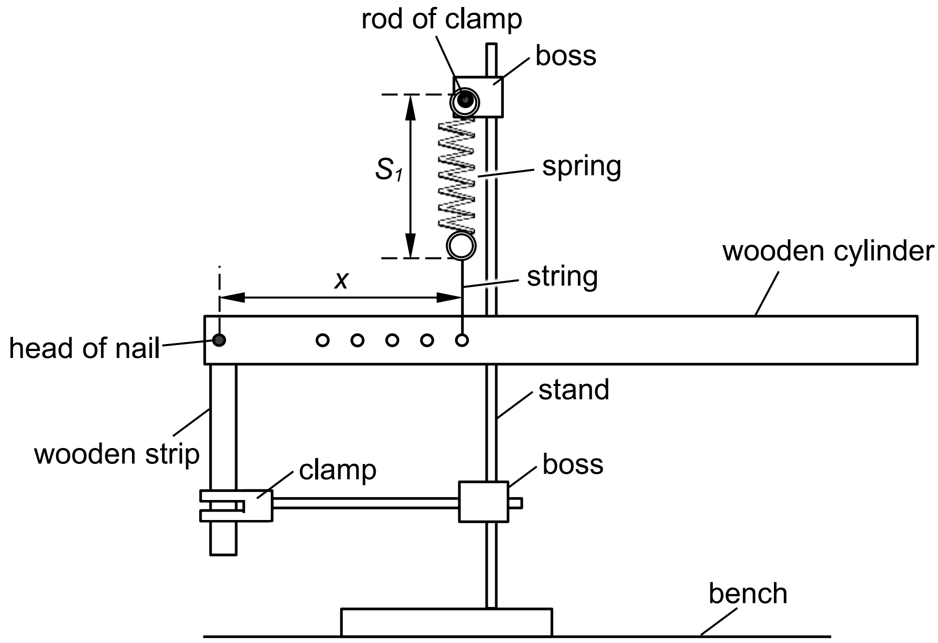

Fig. 2.3

Place the nail through the hole at the end of the wooden cylinder.

Adjust the apparatus until the spring and the wooden strip are vertical and the wooden cylinder is horizontal.

The distance x between the hole with the string and the hole with the nail is shown in Fig. 2.3.

The length of the stretched spring is S_1.

(i) Measure and record x and S_1.

x = ...

S_1 = ... [1]

(ii) Calculate e, where

$$e = S_1 - S.$$

e = ... [1]

(c) Theory suggests that

$$e = \frac{MgL}{2kx}$$

where g is 9.81 N kg^{-1}, M is the mass of the wooden cylinder and k is the spring constant of the spring.

Mass M is given on the card pasted on the wooden cylinder.

(i) Calculate *k.*

k = ... N m^{-1} [2]

(ii) If you were to repeat the experiment using the other holes in the cylinder, describe the graph you would plot to determine k.

....

....

....

.... [2]

[Total: 7]

Candidate Name: ___________________________ **Civics Group:** ____________

3 In this experiment, you will investigate the oscillations of a triangular card.

(a) Cut out an isosceles triangle from the A4 size cardboard given to you as shown in Fig. 3.1.

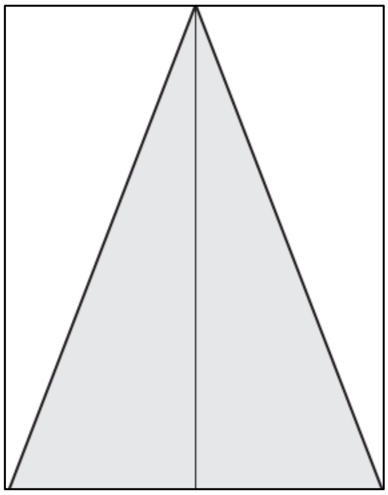

Fig. 3.1

Determine the midpoint M of the shortest side of the triangle and draw a line from M to the opposite corner of the triangle as shown in Fig. 3.2.

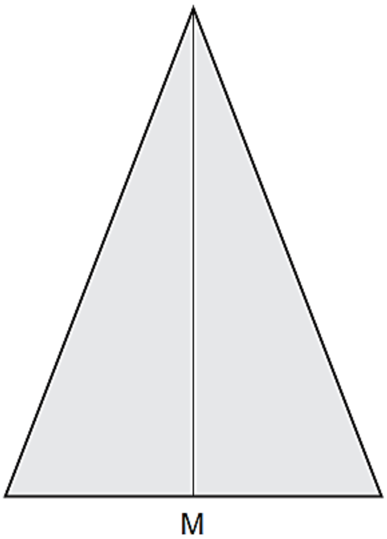

Fig. 3.2

Determine the midpoint N of one of the longer sides. Draw a line from N to the opposite corner of the triangle as shown in Fig. 3.3.

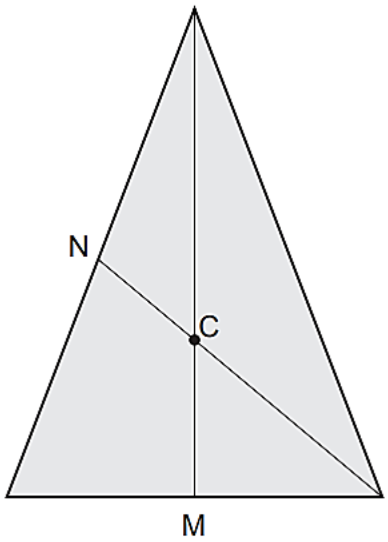

Fig. 3.3

Mark the point C where the two lines cross. The distance between C and M is *d*.

Measure and record *d*.

d = ……………………..…….. m [1]

(b) **(i)** On the line from M to the opposite corner, mark a point P a distance of approximately 0.06 m from C, as shown in Fig. 3.4.

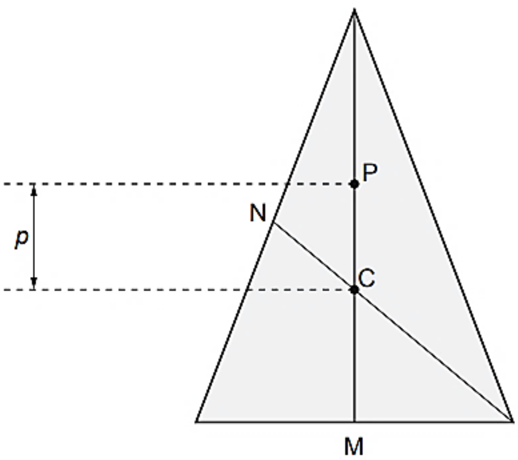

Fig. 3.4

Use the pin to carefully pierce a hole in the card at P. The distance between C and P is *p*, as shown in Fig. 3.4.

Measure and record *p* in metres.

p = ……………………..…….. m [1]

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

percentage uncertainty = ……………………..…….. % [1]

(iii) Place the card on the cork. Put the pin through P into the cork.

Place the paper clip at M.

Set up the apparatus as shown in Fig. 3.5.

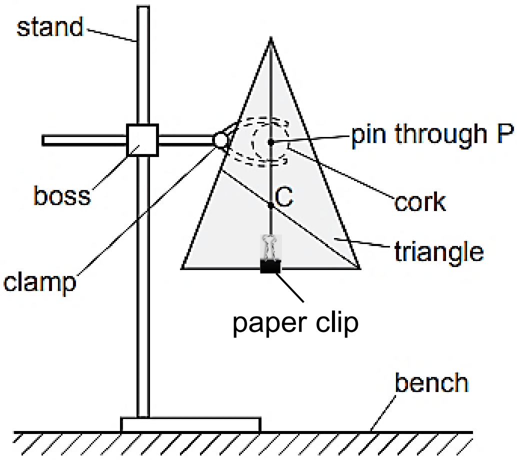

Fig. 3.5

Displace the base of the triangle through a small distance. Release it so that it oscillates about the horizontal axis through the pin as shown in Fig. 3.6.

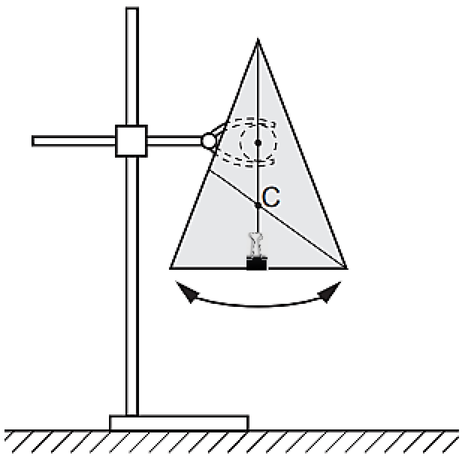

Fig. 3.6

Take measurements to determine the period *T* of the oscillations.

T = ……………………..…….. [2]

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

percentage uncertainty = ………………………..……..% [1]

(v) Calculate p^2 and T^2p.

p^2 = ………………………..……..

T^2p = ………………………..…….. [2]

(vi) Justify the number of significant figures given in your value of T^2p.

………………………………………………………………….……………………….

………………………………………………………………….……………………….

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

(vii) Repeat **(b)(i)**, **(b)(iii)** and **(b)(v)** with a distance *p* of approximately 0.12 m.

p = ………………………..…….. m

T = ………………………..……..

p^2 = ………………………..……..

T^2p = ………………………..…….. [2]

(c) It is suggested that the relationship between T and p is

$$T^2p = qp^2 + S$$

where S has the value 0.020 m s^2 and q is a constant.

Using your values from **b(v)** and **b(vii)** to determine two values of q.

first value of q = ……………………..……..

second value of q = ……………………..…….. [1]

(d) State whether the results of your experiment support the suggested relationship. Justify your conclusion by referring to your values in **(b)(ii)** and **(b)(iv)**.

……………………………………………………………………………………………….

……………………………………………………………………………………………….

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

(e) Theory suggests that

$$q = \frac{4\pi^2}{g}$$

where g is the acceleration of free fall.

Use your value of q to determine g.

g = ……………………..…….. [1]

(f) **(i)** Suggest two significant sources of error in this experiment.

1……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

2……………………………………………………………………………………………

……………………………………………………………………………………………

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

(ii) Suggest an improvement that could be made to the experiment to address one of the errors identified in **(f)(i)**. You may suggest the use of other apparatus or a different procedure.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(g) It was suggested that the period of oscillation *T* for an isosceles triangle cardboard is directly proportional to the length of base of the triangle.

You are given a few pieces of identical cardboard. Describe an experiment to investigate this relationship.

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

[4]

[Total: 21]

BLANK PAGE

Candidate Name: ______________________ **Civics Group:** ____________

4 A solid cylinder floating in oil undergoes vertical oscillations when displaced vertically and released.

Fig. 4.1 shows an example of such a solid cylinder with radius *r*.

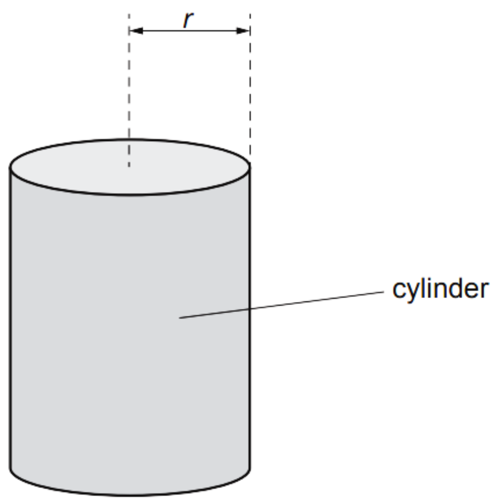

Fig. 4.1

The period of oscillation *T* of the cylinder in oil of density *ρ* is given by

$$T = K\, r^a \rho^b$$

where *K*, *a* and *b* are constants.

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

You are provided with some cylinders of different diameters and some oils of different densities.

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

- the equipment you would use
- the procedure to be followed
- how you would determine the density of the oil
- any precautions that should be taken to improve the accuracy and safety of the experiment.

Diagram

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

[Total: 12]

BLANK PAGE