H2

MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE INTERNATIONAL EDUCATION
General Certificate of Education Advanced Level

CANDIDATE NAME									
CENTRE NUMBER	S					INDEX NUMBER			

0123456789

PHYSICS **9478/04**

Paper 4 Practical **For examination from 2026**

SPECIMEN PAPER **2 hours 30 minutes**

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and index number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use an approved calculator.
- You may use a spreadsheet to process and analyse data.
- Write the details of the shift and laboratory in the boxes provided.
- You will be allowed to work with the apparatus for a maximum of 1 hour 15 minutes for each section.

INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
Total	

This document has **20** pages. Any blank pages are indicated.

Singapore Examinations and Assessment Board

CAMBRIDGE International Education

Section A

1 This experiment considers the forces on a wooden cylinder.

(a) You are provided with a wooden cylinder with a spring attached.

The distance *L* between the centre of the hole with the string and the end of the cylinder is shown in Figure 1.1.

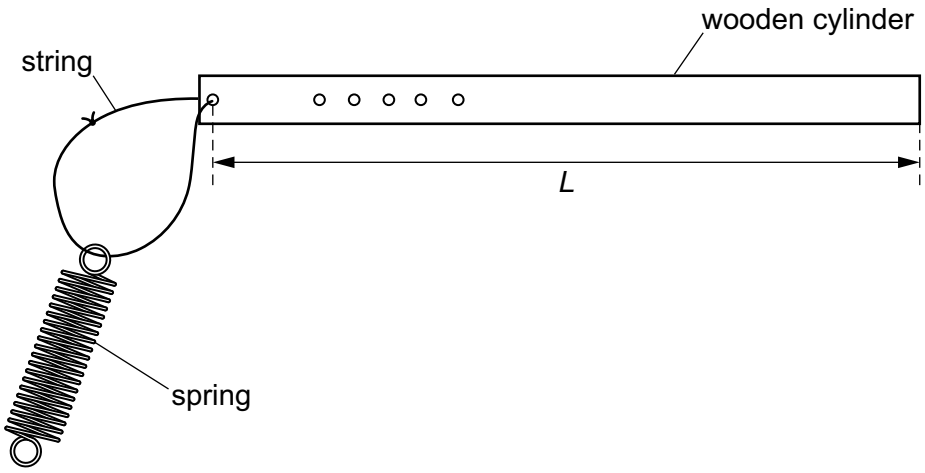

Figure 1.1

The length of the unstretched spring is *S*, as shown in Figure 1.2.

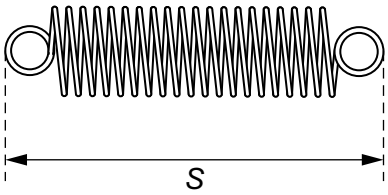

Figure 1.2

Measure and record *L* and *S*.

L = ...

S = ...
[1]

(b) Set up the apparatus as shown in Figure 1.3.

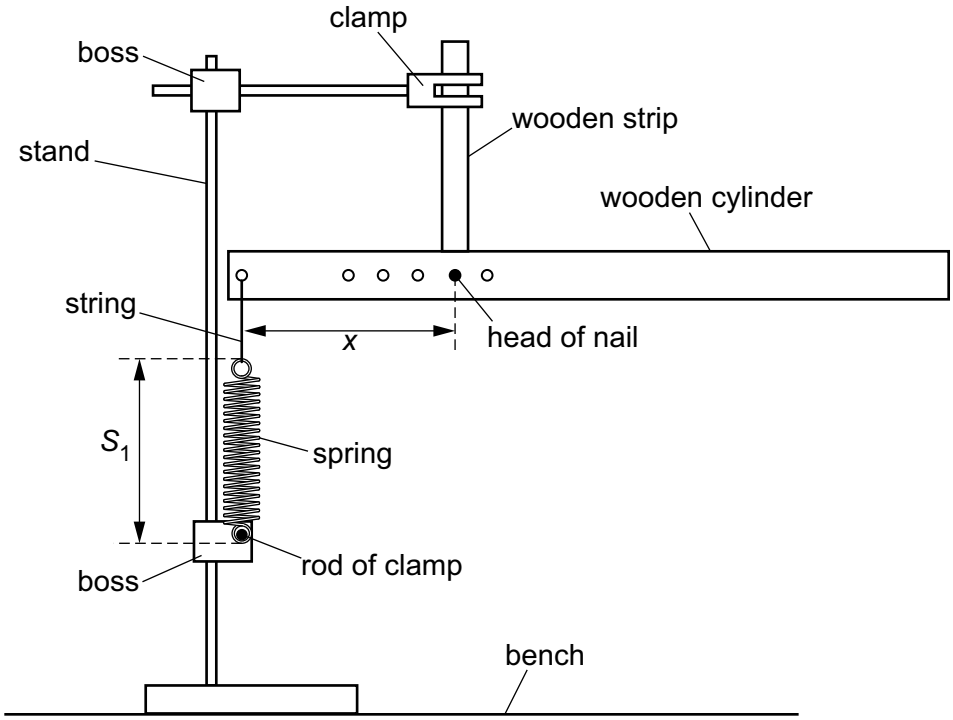

Figure 1.3

Place the nail through one of the holes in the wooden cylinder.

Adjust the apparatus until the spring and 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 Figure 1.3.

The length of the stretched spring is S_1.

(i) Measure and record x and S_1.

x = ...

S_1 = ...
[1]

(ii) Calculate e and n, where:

$$e = S_1 - S \quad \text{and} \quad n = \frac{x}{L}.$$

e = ...

n = ...
[1]

(c) Vary distance *x*.

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

Repeat **1(b)(i)** and **1(b)(ii)**.

Present your results clearly.

[3]

(d) The quantities *e* and *n* are related by the equation:

$$e = \frac{P}{n} + Q$$

where *P* and *Q* are constants.

(i) Plot a suitable graph using a spreadsheet to determine P and Q.

Sketch the graph in the space below. Write down the equation of the trendline.

P = ... m

Q = ... m
[3]

(ii) Theory suggests that:

$$P = \frac{Mg}{2k}$$

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

Mass M is given on the card.

Calculate k.

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

(e) Suggest a theoretical value for e when n is equal to 0.5. Explain your answer.

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.....

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..... [2]

[Total: 12]

2 This investigation considers the current in an RC circuit when a capacitor of capacitance C charges and discharges.

Set up the circuit shown in Figure 2.1, taking care to connect the capacitor the right way round. Switch S is initially unconnected.

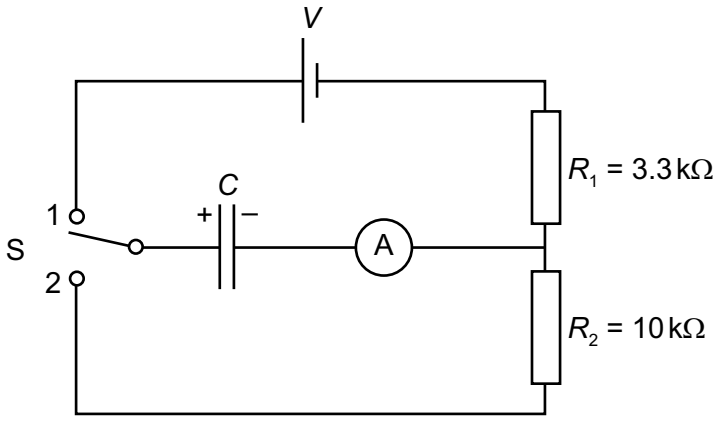

Figure 2.1

(a) (i) Set switch S to position 1 and wait about 20 s.

Record the reading I on the ammeter.

I = ... [1]

(ii) Set switch S to position 2 and immediately start the stopwatch.

Record I every 10 s from time t = 0 to t = 50 s. Tabulate your results.

You may need several attempts before you have a complete set of results.

[2]

(iii) Describe **one** problem in taking the readings.

.....

..... [1]

(b) An engineer wants to test the capacitance of an unmarked capacitor in order to design a circuit to filter noise from received signals.

To determine the unknown value of C, the engineer uses an RC circuit similar to that in Figure 2.1 but with different values of V, R_1 and R_2.

The engineer discharges the fully charged capacitor through resistor R_2.

The current in the circuit decreases exponentially with discharging time t from an initial value I_0 in the form:

$$I = I_0 e^{-\frac{t}{\tau}}$$

where τ is the time constant of the discharging circuit.

The engineer's discharging data is recorded in the digital file: datasetQ2b.csv.

Imagine you are the engineer.

(i) Use the engineer's data to estimate the charge Q_1 that flows through the circuit during discharging.

Q_1 = ... [1]

(ii) Explain how you obtained the value of Q_1.

.....

..... [1]

(iii) Plot a suitable graph using a spreadsheet to determine the time constant τ of the engineer's discharging circuit.

Sketch the graph in the space below. Write down the equation of the trendline.

τ = ...
[2]

(c) The electric potential energy U stored in a capacitor of known capacitance C is given by:

$$U = \frac{1}{2}CV^2$$

where V is the potential difference (p.d.) across the capacitor.

Plan an investigation to determine the difference between the energy stored on the fully charged capacitor in Figure 2.1 and the work done by the cell in fully charging the capacitor.

You are not required to do this experiment.

Include in your plan:

- a circuit diagram
- the procedure to be followed
- how the work done by the cell is determined while the capacitor is charging
- any precautions that should be taken to improve the accuracy and/or the safety of the investigation.

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

Diagram

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[6]

[Total: 14]

Section B

3 This experiment concerns a coupled pendulum system.

Figure 3.1 shows six pendulums, 1, 2, 3, 4, 5 and 6, connected to a common string.

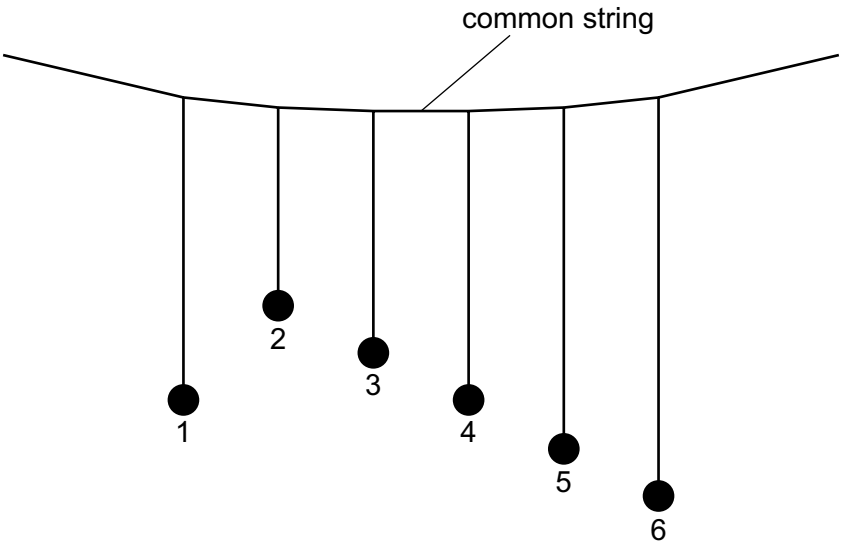

Figure 3.1

When pendulum 1 is set swinging, the other pendulums move.

You will investigate how these properties affect the behaviour of a coupled pendulum system:

- the distance between pendulums
- the tension in the common string
- the difference in pendulum lengths
- the mass of the pendulum bobs.

Turn over

(a) (i) Set up two pendulums A and B as shown in Figure 3.2. Place the loops of the common string on the rods of the clamps. The distance *x* between the pendulum strings is shown.

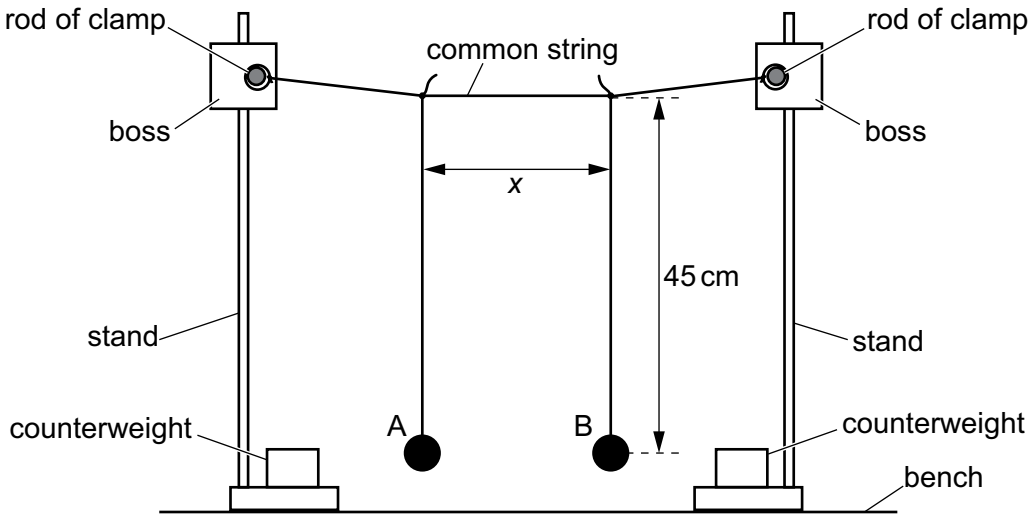

Figure 3.2

Adjust the distance between the stands so that the common string is taut but **not** as taut as possible.

Adjust the knots until each pendulum has a length equal to 45 cm and *x* is approximately 15 cm.

Measure and record *x*.

x = ... cm

Pull pendulum A towards you, perpendicular to the plane containing both pendulums. Release the pendulum. Pendulum A will swing then pendulum B will start to swing. After some time, A will stop swinging while B carries on swinging.

The time *t* is the time between releasing A and A stopping for the first time.

Measure and record *t*.

t = ... s
[2]

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

percentage uncertainty in *t* = ... [1]

(iii) It is also possible to determine t using B. The time $2t$ is the time between releasing A and B stopping for the first time.

Discuss whether this second method of determining t is better or worse than the method used in **3(a)(i)**.

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..... [2]

(b) (i) Repeat **3(a)(i)** for at least two more values of x in the range 5 cm to 25 cm.

Tabulate these results. Include the results from **3(a)(i)**.

[2]

(ii) Comment on the trend in your results.

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..... [1]

(c) In the following experiments, you will use the **same value of *x*** throughout.

Choose **one** value of *x* from the values in **3(b)(i)** to use in the following experiments.

Record your choice of *x*.

x = ... cm

Explain your choice of *x*.

.....

.....

.....

[1]

(d) **(i)** For the arrangement shown in Figure 3.2, adjust the positions of the pendulums to make *x* equal to the value chosen in **3(c)**.

Gently move the stands apart so that the common string is as taut as possible without the stands falling over. This will increase the tension in the common string.

Measure and record *t*.

t = ...

Comment on the effect on *t* of increasing the tension in the common string.

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[1]

(ii) Describe, using a diagram, how you could use a spring to investigate the effect of tension in the common string on *t*.

You are not required to do this experiment.

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

Diagram

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[4]

(e) Keep x equal to the value chosen in **3(c)**.

The distance y is the difference in length between the two pendulums, as shown in Figure 3.3.

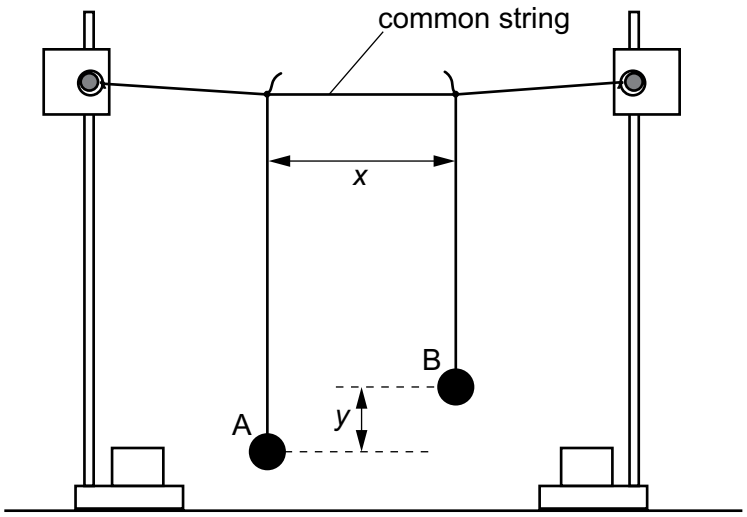

Figure 3.3

(i) Reduce the length of pendulum B until y is approximately 4 cm.

Measure and record y and t.

y = ... cm

t = ...
[1]

(ii) Reduce the length of pendulum B until y is approximately 8 cm.

Measure and record y and t.

y = ... cm

t = ...
[1]

(iii) It is suggested that:

$$t = \frac{k}{y}$$

where k is a constant.

Use your values from **3(e)(i)** and **3(e)(ii)** to determine **two** values of k.

first value of k = ...

second value of k = ...
[2]

(iv) Justify the number of significant figures given in your values of k.

.....

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..... [1]

(v) State whether the results of your experiment support the relationship suggested in **3(e)(iii)**.

Justify your conclusion by referring to your answer in **3(a)(ii)**.

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..... [1]

(f) Figure 3.4 shows two pendulums of equal length. The pendulum bobs consist of a number of slotted masses.

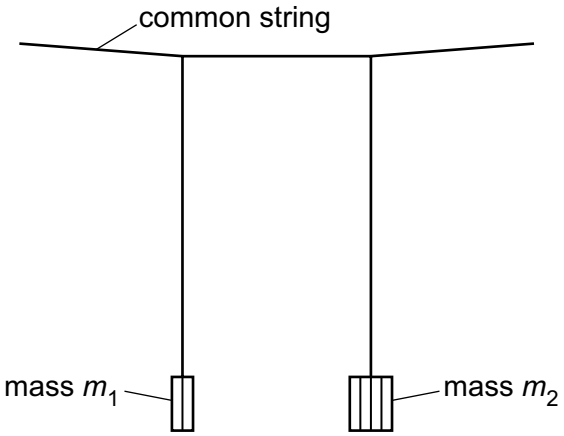

Figure 3.4

In an investigation, mass m_1 is fixed at 40 g, mass m_2 is varied and t is measured.

Table 3.1 shows data for m_2 and t.

Table 3.1

m_2 / g	80	100	120	140	160
t / s	37.78	31.07	26.86	22.33	16.88
$(m_2 - m_1)$ / g					

Complete Table 3.1.

Plot a suitable graph using a spreadsheet to determine t when the two masses are equal.

Sketch the graph in the space below. Write down the equation of the trendline.

t = ... s
[4]

[Total: 24]

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