Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

4972456805

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **May/June 2023**

2 hours

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 candidate 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 or correction fluid.
- Do **not** write on any bar codes.
- You will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

For Examiner's Use	
1	
2	
Total	

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You may not need to use all of the materials provided.

1 In this experiment, you will investigate a balanced metre rule.

You have been provided with three springs and a metre rule with masses attached to its centre.

(a) The unstretched length of the single spring is S_1, as shown in Fig. 1.1.

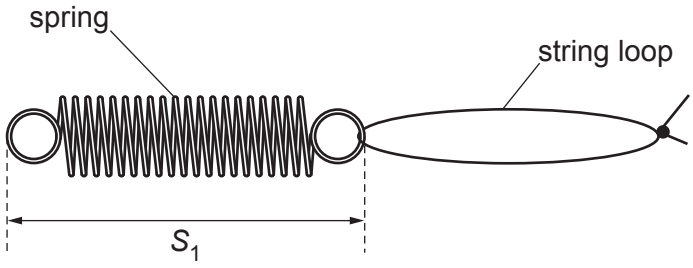


Fig. 1.1

The unstretched length of the connected springs is S_2, as shown in Fig. 1.2.

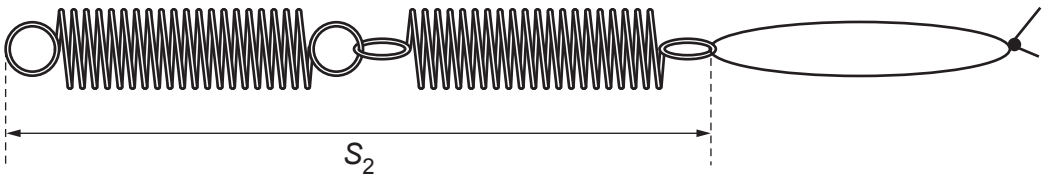


Fig. 1.2

Measure and record S_1 and S_2.

S_1 = ...

S_2 = ...
[1]

(b) (i) ● Set up the apparatus as shown in Fig. 1.3.

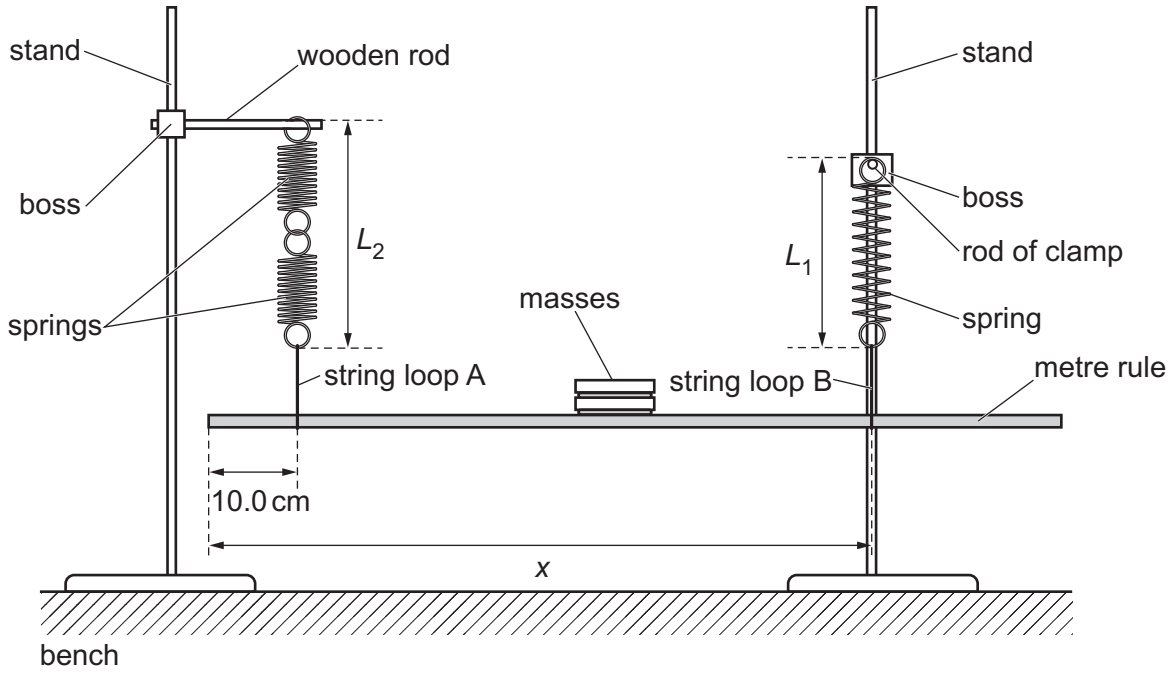


Fig. 1.3

- Two string loops A and B are supporting the rule.

  Loop A should be placed 10.0 cm from one end of the rule.

- The distance between the end of the rule and loop B is x. Move loop B until x is approximately 75 cm.

- Measure and record x.

  x = ...

- Without changing the positions of the string loops, adjust the apparatus until the rule is parallel to the bench and the springs and the string loops are vertical.

- The extended length of the single spring is L_1.
  The extended length of the connected springs is L_2.

  Measure and record L_1 and L_2.

  L_1 = ...

  L_2 = ...

  [1]

(ii) Calculate e_1 and e_2, where

$$e_1 = L_1 - S_1 \text{ and } e_2 = L_2 - S_2.$$

e_1 = ...

e_2 = ...

[1]

(c) Vary x by changing the position of loop B. Loop B must remain on the right-hand side of the masses. Keep loop A in the **same** position.

For each value of x, adjust the apparatus until the rule is parallel to the bench and the springs and the string loops are vertical. Measure x, L_1 and L_2. Repeat until you have five sets of values.

Record your results in a table. Include values of e_1, e_2 and $\frac{e_2}{e_1}$ in your table.

[8]

(d) **(i)** Plot a graph of $\frac{e_2}{e_1}$ on the y-axis against x on the x-axis. [3]

(ii) Draw the straight line of best fit. [1]

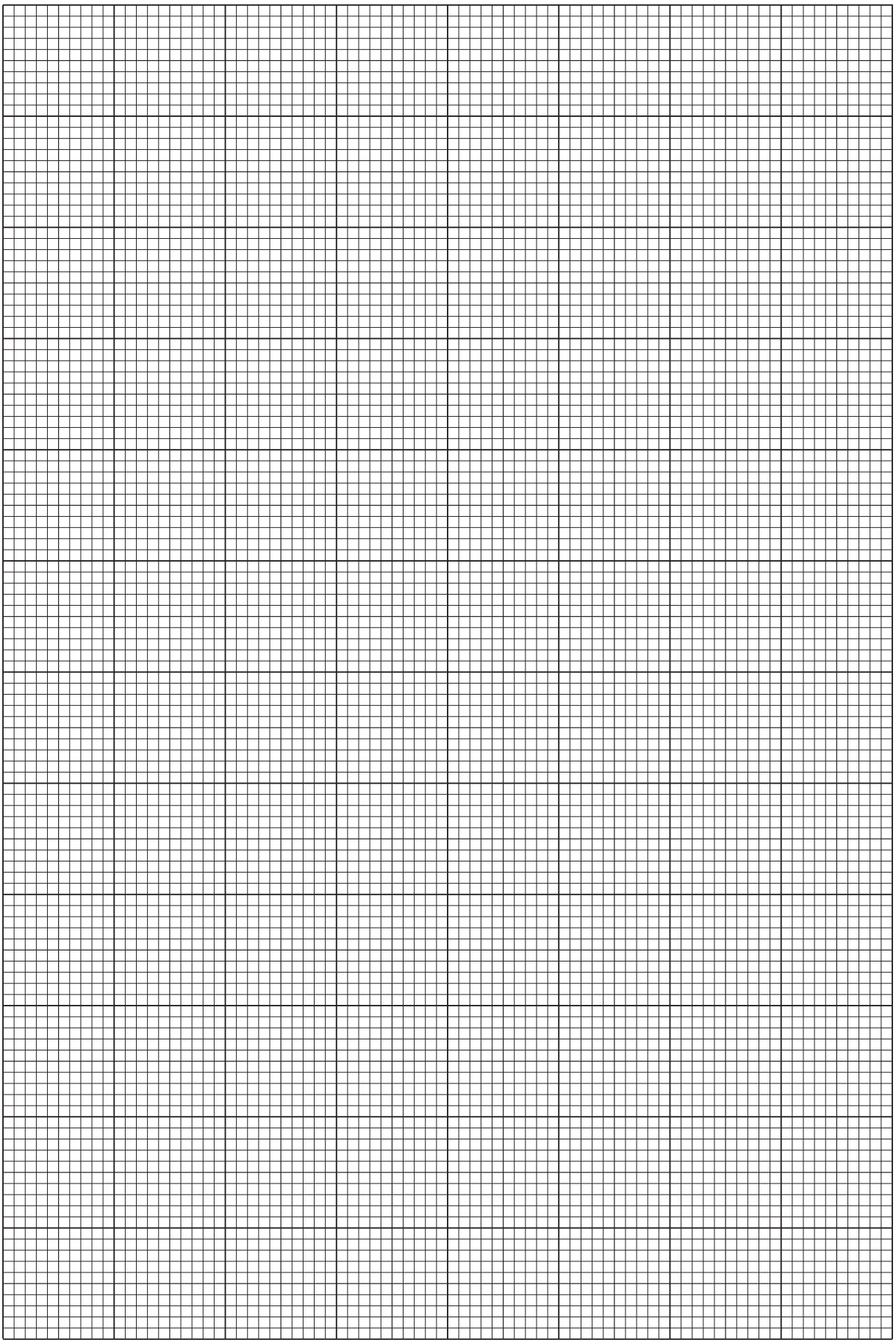
(iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

[2]

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[Turn over

(e) It is suggested that the quantities e_1, e_2 and x are related by the equation

$$\frac{e_2}{e_1} = Px - Q$$

where P and Q are constants.

Using your answers in **(d)(iii)**, determine the values of P and Q.
Give appropriate units.

P = ...

Q = ...
[2]

(f) The distance between string loop A and the centre of the rule is w, as shown in Fig. 1.4.

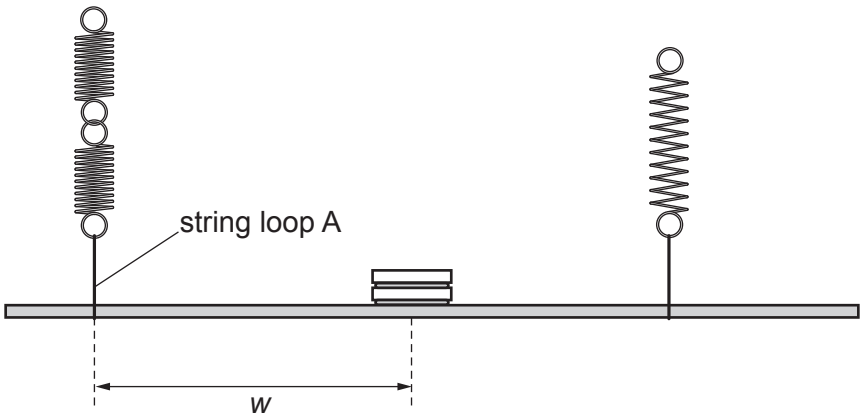


Fig. 1.4

P and Q are each inversely proportional to w.

A student repeats the experiment with loop A placed further from the left-hand end of the rule.

Sketch a second line on the graph to show the expected results.
Label this line W. [1]

[Total: 20]

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You may not need to use all of the materials provided.

2 In this experiment, you will investigate the oscillations of a wooden strip and a pendulum.

You have been provided with a wooden strip with two holes G and H.

(a) ● Place the wooden strip on the pivot as shown in Fig. 2.1.

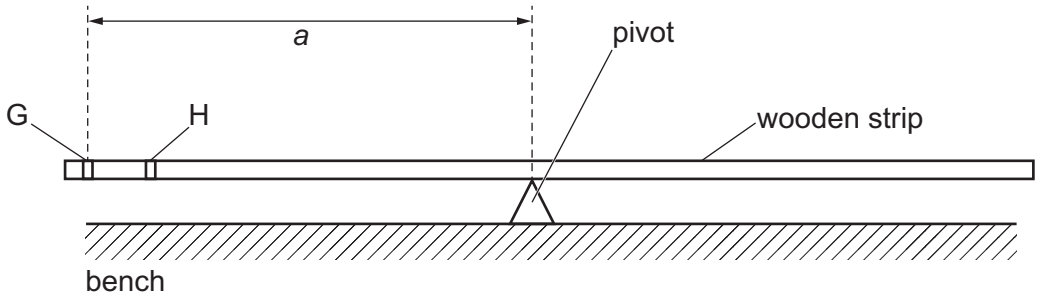


Fig. 2.1

- Adjust the position of the strip on the pivot until the strip balances.
- The distance between G and the pivot is *a*.

  Without marking the strip, measure and record *a*.

a = ... [1]

(b) ● Set up the apparatus as shown in Fig. 2.2 with the nail through G.

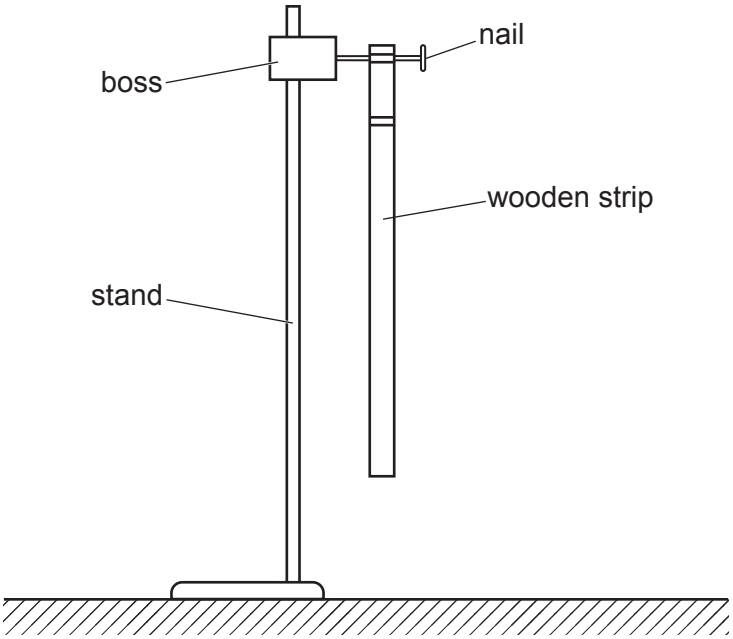


Fig. 2.2

- Pull the bottom of the strip towards you through a short distance.
- Release the strip. The strip will oscillate. The time for 10 oscillations is *t*.

  Measure and record *t*.

t = ... [2]

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(c) (i) ● Set up the pendulum as shown in Fig. 2.3.

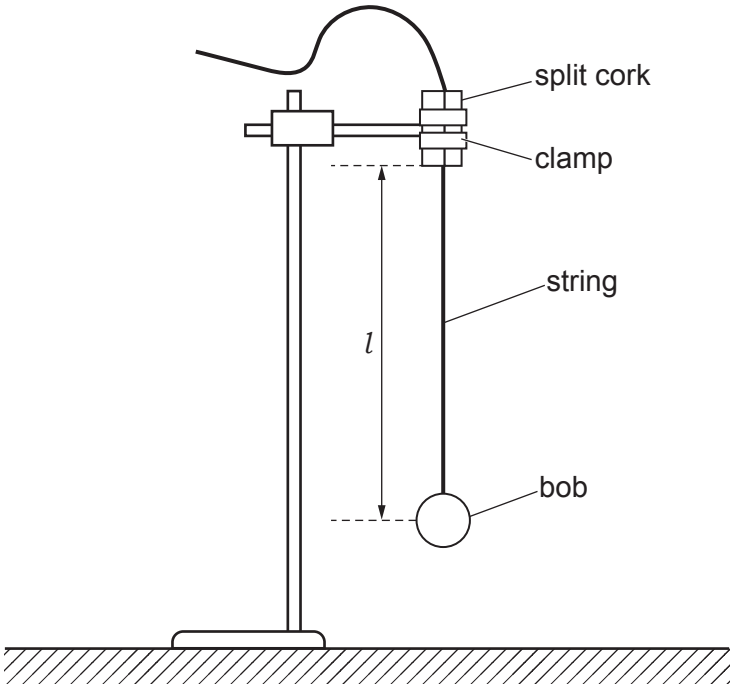


Fig. 2.3

- The distance between the bottom of the split cork and the centre of the bob is l.

  Adjust the position of the string in the split cork until l is approximately 35 cm.
- Pull the bob towards you through a short distance.
- Release the bob. The bob will oscillate.
- Adjust l until the time for 10 oscillations is the same as the value of t in **(b)**.
- Measure and record l.

l = ...

- Calculate $(l - a)$.

$(l - a)$ = ...
[1]

(ii) Estimate the percentage uncertainty in your value of $(l - a)$. Show your working.

percentage uncertainty = ... % [1]

(d) • Using hole H, repeat **(a)**.

a = ...

• Using hole H, repeat **(b)**.

t = ...

• Using this value of t, repeat **(c)(i)**.

l = ...

$(l - a)$ = ...
[3]

(e) It is suggested that the relationship between l and a is

$$(l - a) = \frac{C}{a}$$

where C is a constant.

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

first value of C = ...

second value of C = ...
[1]

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

.....

.....

..... [1]

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(f) It is suggested that the percentage uncertainty in the values of C is 5%.

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

.....

.....

.....

..... [1]

(g) Theory suggests that

$$g = \frac{4\pi^2}{T^2}\left(a + \frac{C}{a}\right)$$

where T is the period of the oscillations of the wooden strip and g is the acceleration of free fall.

- Use your value of t from **(d)** to determine T.

T = ...

- Use your value of a from **(d)** and the corresponding value of C to determine a value for g. Give an appropriate unit.

g = ...
[1]

(h) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....

[4]

(ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....

[4]

[Total: 20]

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