

Cambridge International AS & A Level

CANDIDATE
NAME

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CENTRE
NUMBER

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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	

This document has **12** pages.

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.

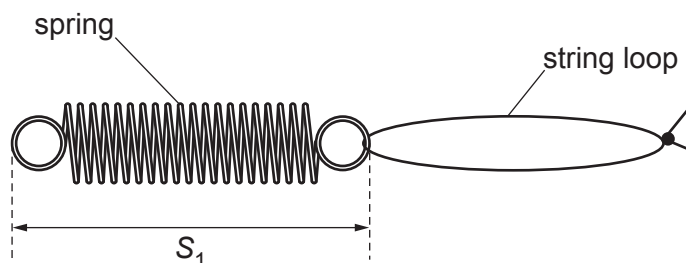


Fig. 1.1

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

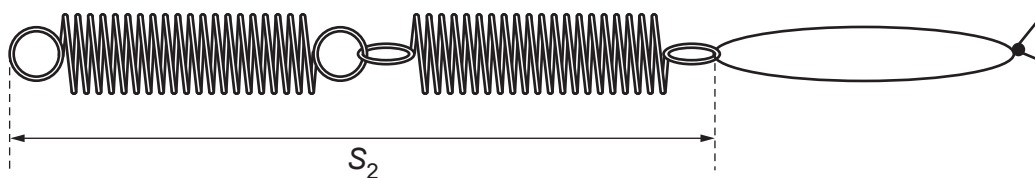


Fig. 1.2

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.

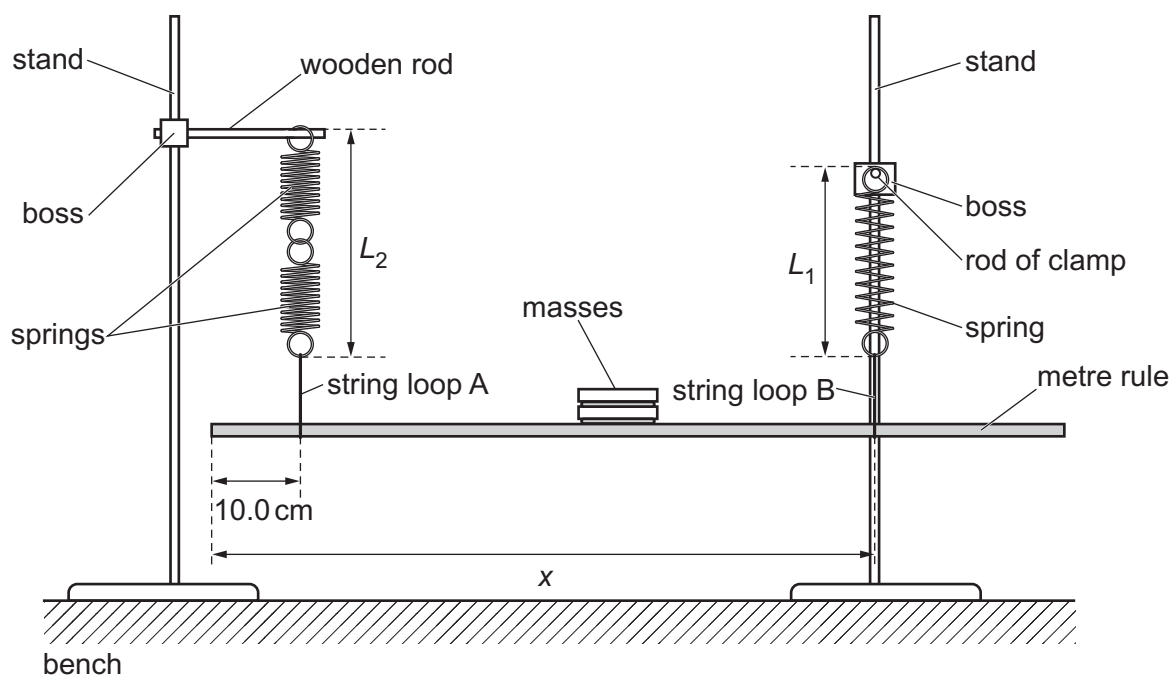


Fig. 1.3

- 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

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

$e_1 =$

$e_2 =$

- (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.

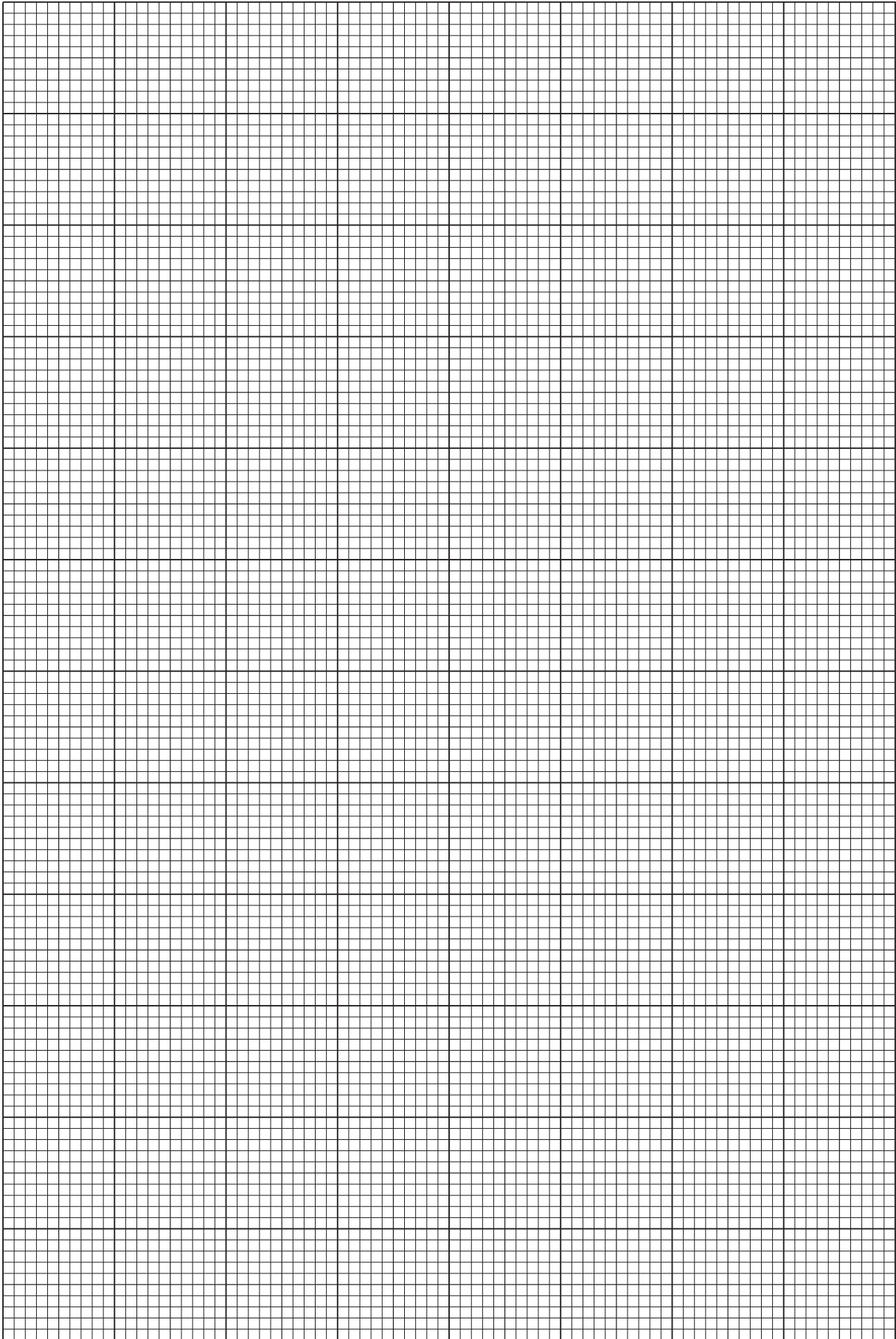
Record your results in a table. Include values of e_1 , e_2 and $\frac{e_2}{e_1}$ in your table.

- [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]



- (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.

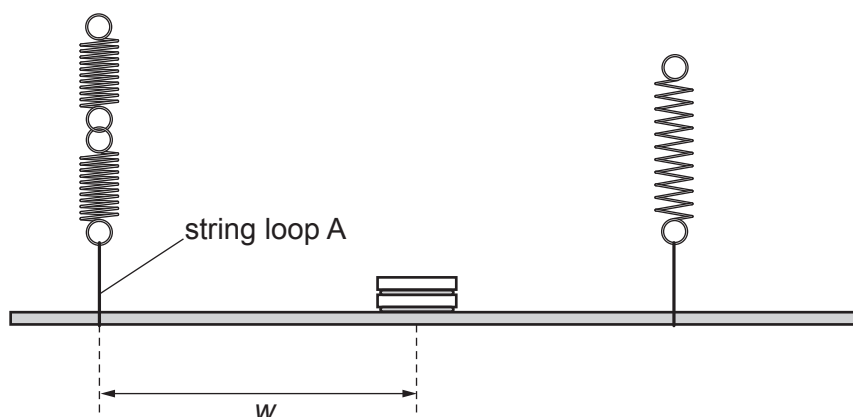


Fig. 1.4

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]

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.

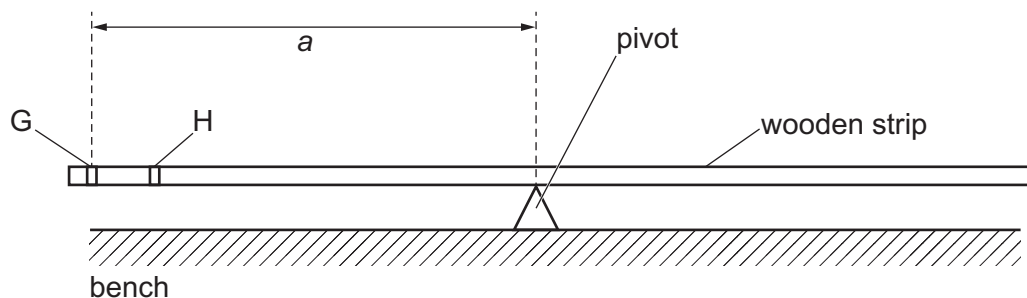


Fig. 2.1

- 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.

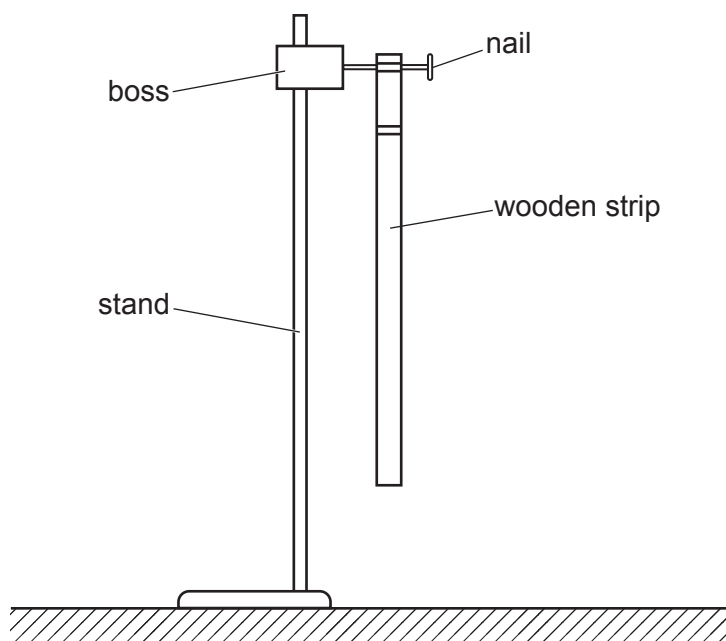


Fig. 2.2

- 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 .

$t = \dots\dots\dots$ [2]

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

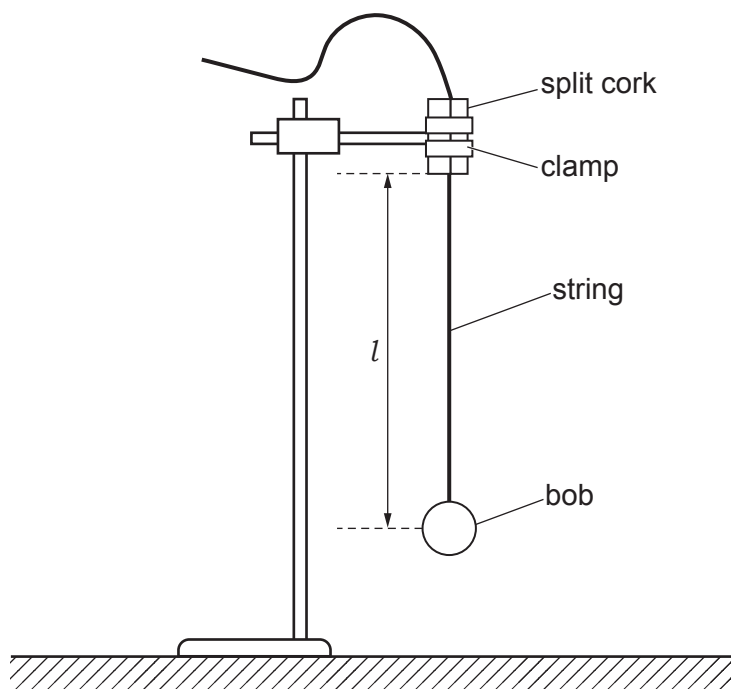


Fig. 2.3

- 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).

$$a = \dots\dots\dots$$

- Using hole H, repeat (b).

$$t = \dots\dots\dots$$

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

$$l = \dots\dots\dots$$

$$(l - a) = \dots\dots\dots [3]$$

- (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 .

$$\text{first value of } C = \dots\dots\dots$$

$$\text{second value of } C = \dots\dots\dots [1]$$

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

.....

 [1]

- (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

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2

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3

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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

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2

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3

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4

.....

[4]

[Total: 20]

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