



# Cambridge International AS & A Level

CANDIDATE  
NAME

CENTRE  
NUMBER

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**PHYSICS**

**9702/31**

Paper 3 Advanced Practical Skills 1

**May/June 2022**

**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	
<b>Total</b>	

This document has **12** pages.

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

1 In this experiment, you will investigate the motion of a spring system.

You have been provided with two springs connected by string.

(a) • Set up the apparatus as shown in Fig. 1.1.

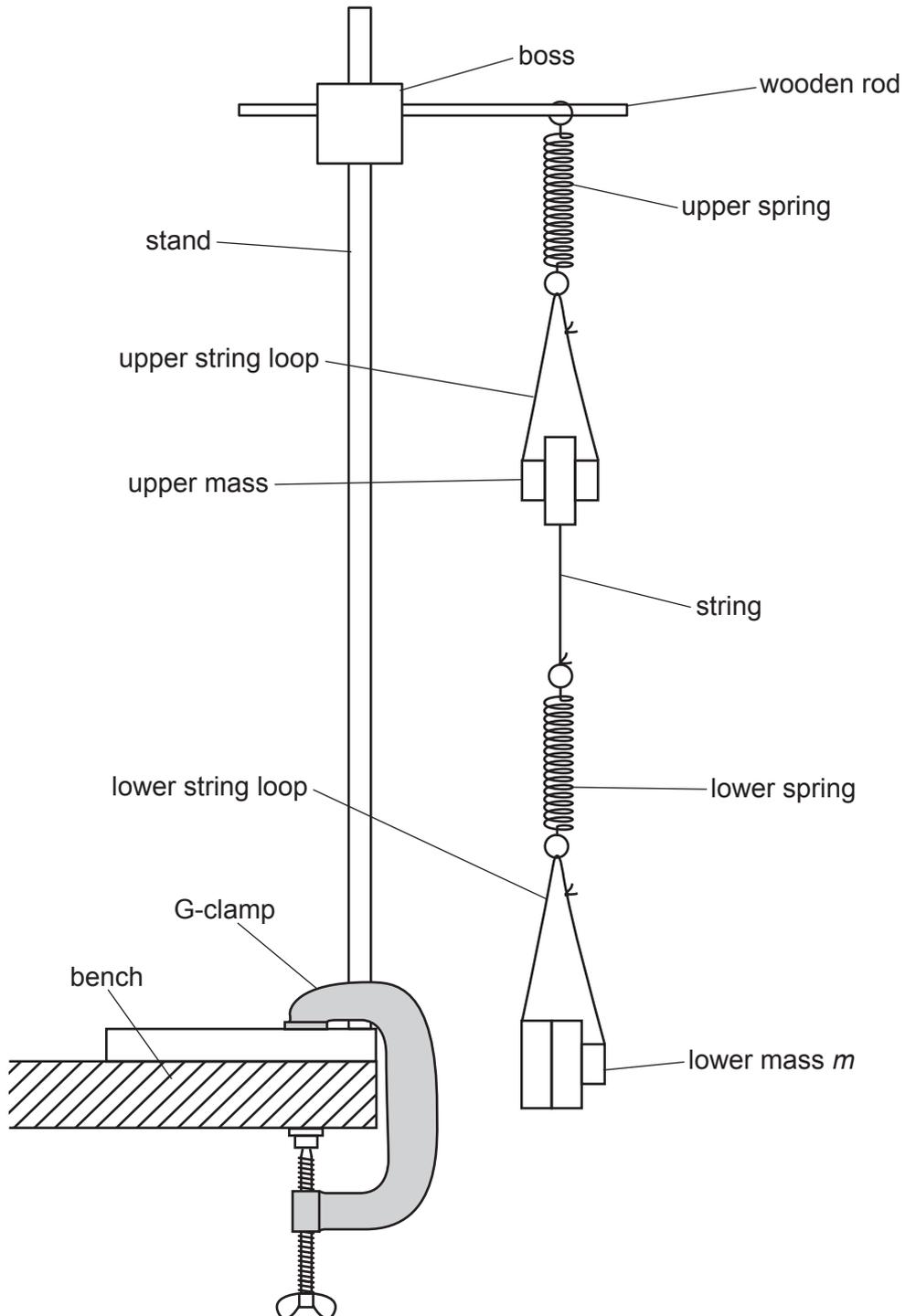


Fig. 1.1

- The lower mass is  $m$ . Arrange **all** of the slotted masses so that  $m$  is 250g and the remaining slotted masses are in the upper string loop.
- Pull the **lower** mass down through a short distance.
- Release the mass. The system will oscillate.
- Determine the period  $T$  of the oscillations of the **upper** mass.

$$T = \dots\dots\dots [2]$$

- (b)
- Transfer some of the slotted masses from the lower string loop to the upper string loop.
  - Record the value of the upper mass.

$$\text{upper mass} = \dots\dots\dots$$

- Record the value of  $m$ .

$$m = \dots\dots\dots$$

- Determine the period  $T$  of the oscillations of the **upper** mass.

$$T = \dots\dots\dots [1]$$

- (c) Change  $m$  by moving slotted masses between the two string loops and then determine  $T$ .

Repeat until you have six sets of values of  $m$  and  $T$ . You may include your results from (a) and (b).

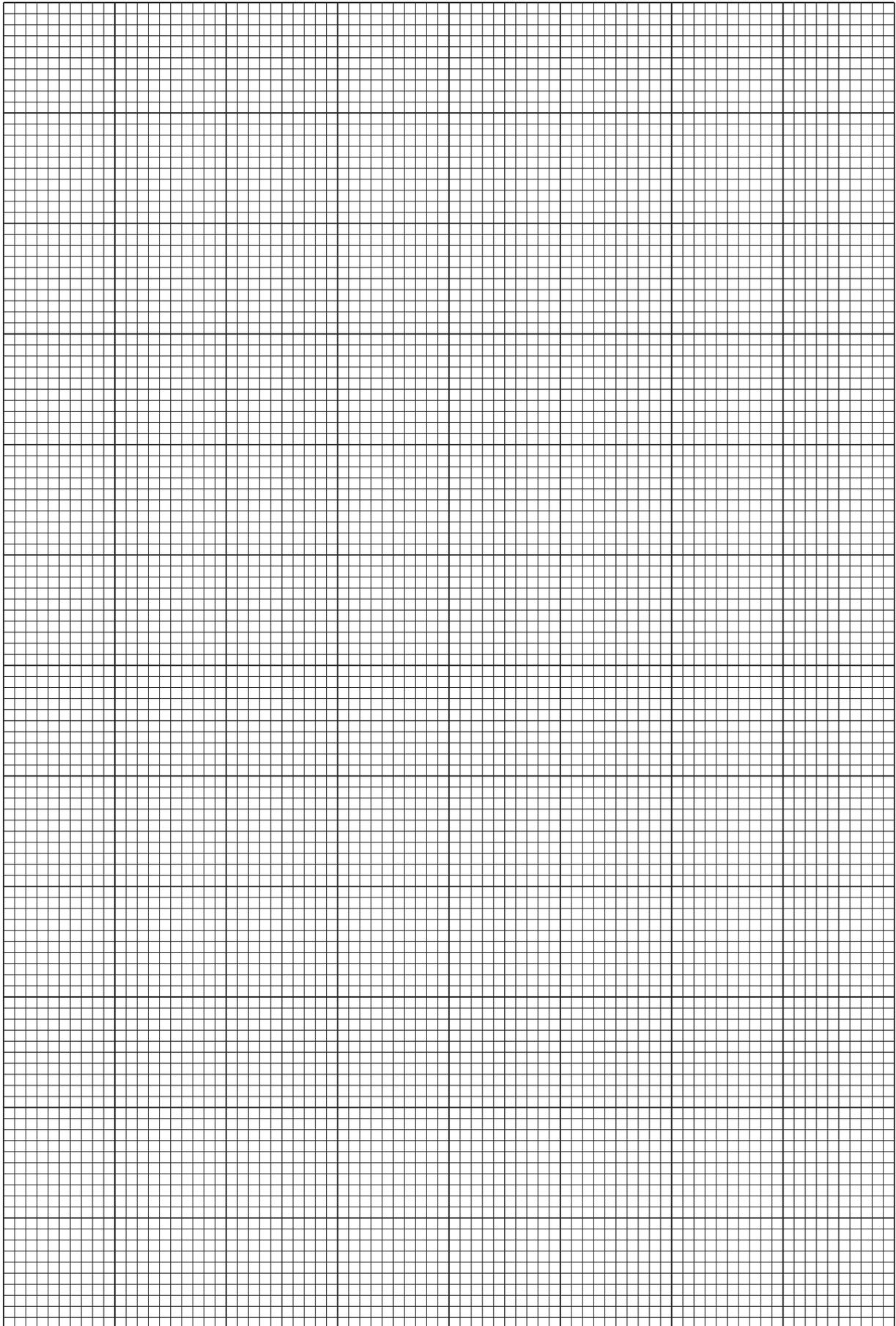
Record your results in a table. Include values of  $\sqrt{T}$  in your table.

- (d) (i) Plot a graph of  $\sqrt{T}$  on the  $y$ -axis against  $m$  on the  $x$ -axis. [9]
- (ii) Draw the straight line of best fit. [3]
- (iii) Determine the gradient and  $y$ -intercept of this line. [1]

gradient = .....

$y$ -intercept = .....

[2]



(e) It is suggested that the quantities  $T$  and  $m$  are related by the equation

$$\sqrt{T} = Pm + Q$$

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]

[Total: 20]

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

2 In this experiment, you will investigate the equilibrium of a metre rule.

You have been provided with a metre rule and a tube.

- (a) (i) • The distance between the centre of the hole in the metre rule and the 50 cm mark on the metre rule is  $L$ , as shown in Fig. 2.1.

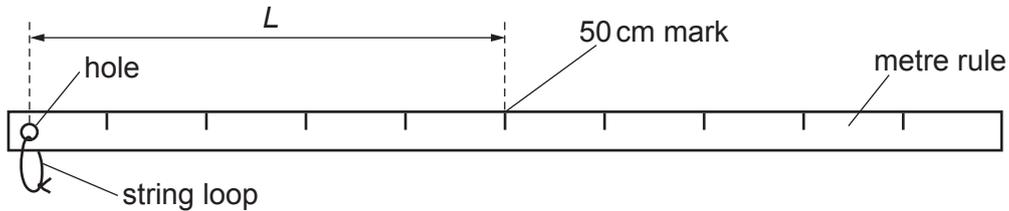


Fig. 2.1

Determine  $L$ . Give your value in metres.

$L = \dots\dots\dots$  m

- The outer diameter of the tube is  $d$ , as shown in Fig. 2.2.

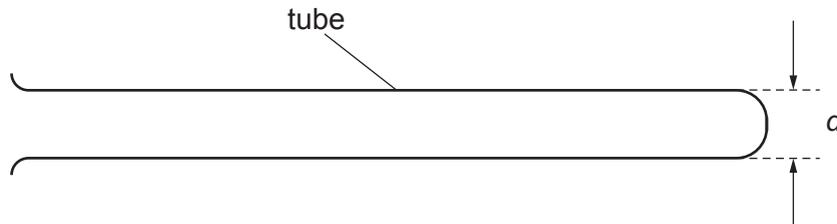


Fig. 2.2

Measure and record  $d$ . Give your value in metres.

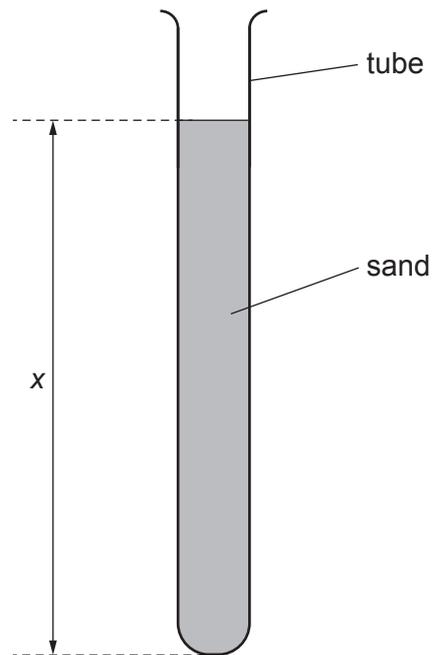
$d = \dots\dots\dots$  m  
[1]

- (ii) Calculate the cross-sectional area  $A$  of the tube where

$$A = \frac{\pi d^2}{4}.$$

$A = \dots\dots\dots$  m<sup>2</sup> [1]

- (b) (i) • Add sand to the tube as shown in Fig. 2.3.



**Fig. 2.3**

- The height of sand in the tube is  $x$ .

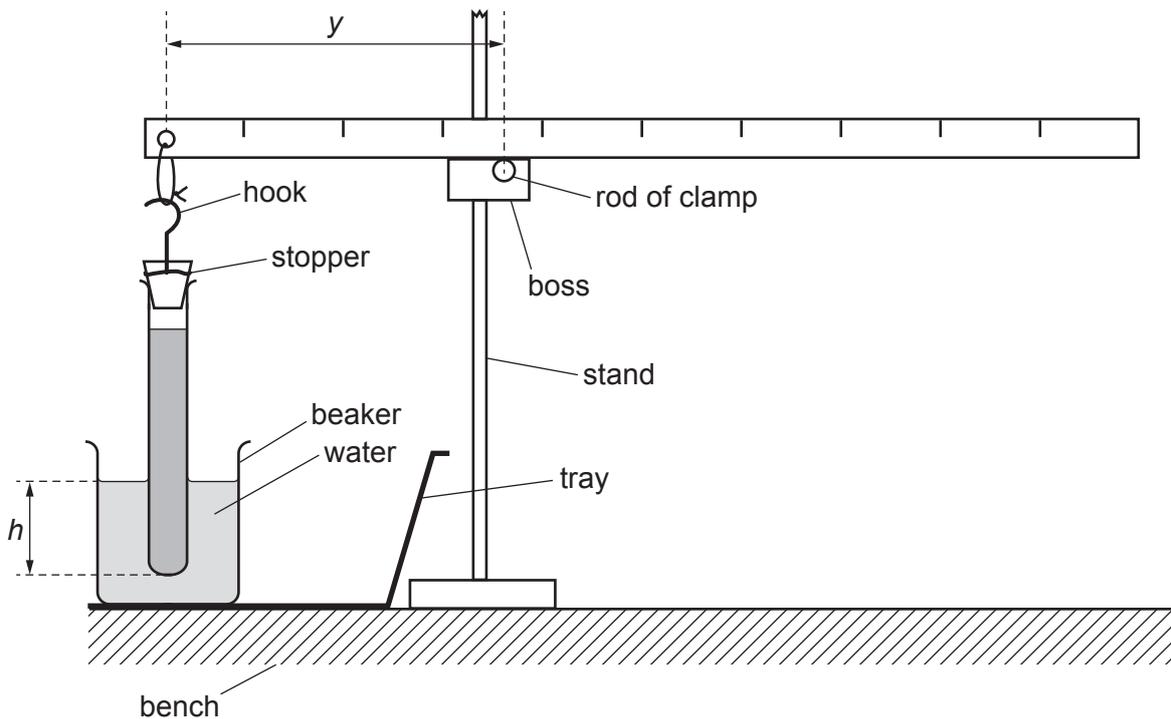
Adjust the amount of sand in the tube until  $x$  is approximately 12 cm.

- Measure and record  $x$ . Give your value in metres.

$x = \dots\dots\dots$  m

- Push the stopper securely into the tube.

- Set up the apparatus as shown in Fig. 2.4. Place the beaker containing water inside the tray.



**Fig. 2.4** (not to scale)

- Using the hook, suspend the tube from the string loop and place the tube in the water.
- The distance between the bottom of the tube and the surface of the water in the beaker is  $h$ .

Adjust the apparatus so that the rule is balanced on the rod of the clamp, the rule is parallel to the bench and the value of  $h$  is approximately 5 cm.

- The distance between the rod of the clamp and the hole in the rule is  $y$ .

Measure and record  $h$  and  $y$ . Give your values in metres.

$h = \dots\dots\dots$  m

$y = \dots\dots\dots$  m  
[2]

(ii) Estimate the percentage uncertainty in your value of  $h$ . Show your working.

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

(iii) • The mass  $M$  of the metre rule and string is given on the card.

Write down the value of  $M$ .

$M =$  ..... kg

• Calculate  $C$  using

$$C = \frac{1}{L} \left( 1 - \frac{Ah\rho}{M} \right)$$

where  $\rho = 1.0 \times 10^3 \text{ kg m}^{-3}$ .

$C =$  .....  $\text{m}^{-1}$   
[1]

(iv) Justify the number of significant figures that you have given for your value of  $C$ .

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

(c) • Remove some of the sand from the tube so that  $x$  is approximately 8 cm.

Measure and record  $x$ .

$x =$  ..... m

- Set up the apparatus as shown in Fig. 2.4.
- Adjust the apparatus so that the rule is parallel to the bench and  $h$  has the same value as in (b)(i).
- Measure and record  $y$ .

$y =$  ..... m  
[3]

(d) It is suggested that the relationship between  $y$ ,  $x$  and  $C$  is

$$\frac{1}{y} = kx + C$$

where  $k$  is a constant.

Using your data, calculate two values of  $k$ .

first value of  $k$  = .....

second value of  $k$  = .....

[1]

(e) It is suggested that the percentage uncertainty in the values of  $k$  is 10%.

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

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

(f) (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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