



# Cambridge International AS & A Level

CANDIDATE  
NAME

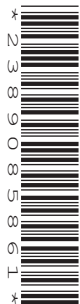
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CENTRE  
NUMBER

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**PHYSICS**

**9702/36**

Paper 3 Advanced Practical Skills 2

**October/November 2021**

**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 **16** pages. Any blank pages are indicated.

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

1 In this experiment, you will investigate the oscillations of a wooden strip.

(a) (i) • Assemble the apparatus as shown in Fig. 1.1 with the nail held securely in the boss.

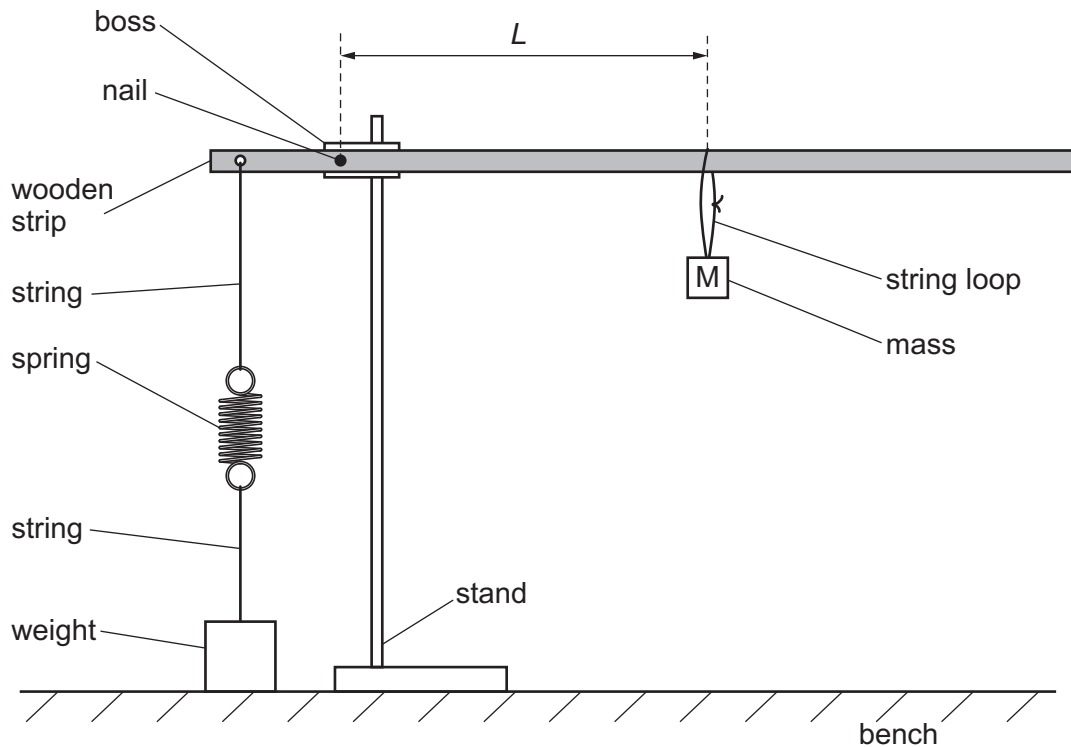


Fig. 1.1

- Hang the mass labelled  $M$  midway between the nail and the end of the strip.
- Adjust the height of the boss so that the strip is parallel to the bench.
- Move the weight so that the spring is vertical.
- $L$  is the distance between the nail and the string loop attached to  $M$ , as shown in Fig. 1.1.

Measure and record  $L$ .

$L = \dots\dots\dots$  [1]

- (ii)
- Pull the free end of the strip down by approximately 2 cm. Release the strip so that it oscillates.
  - Take measurements to determine the period  $T$  of the oscillations.

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

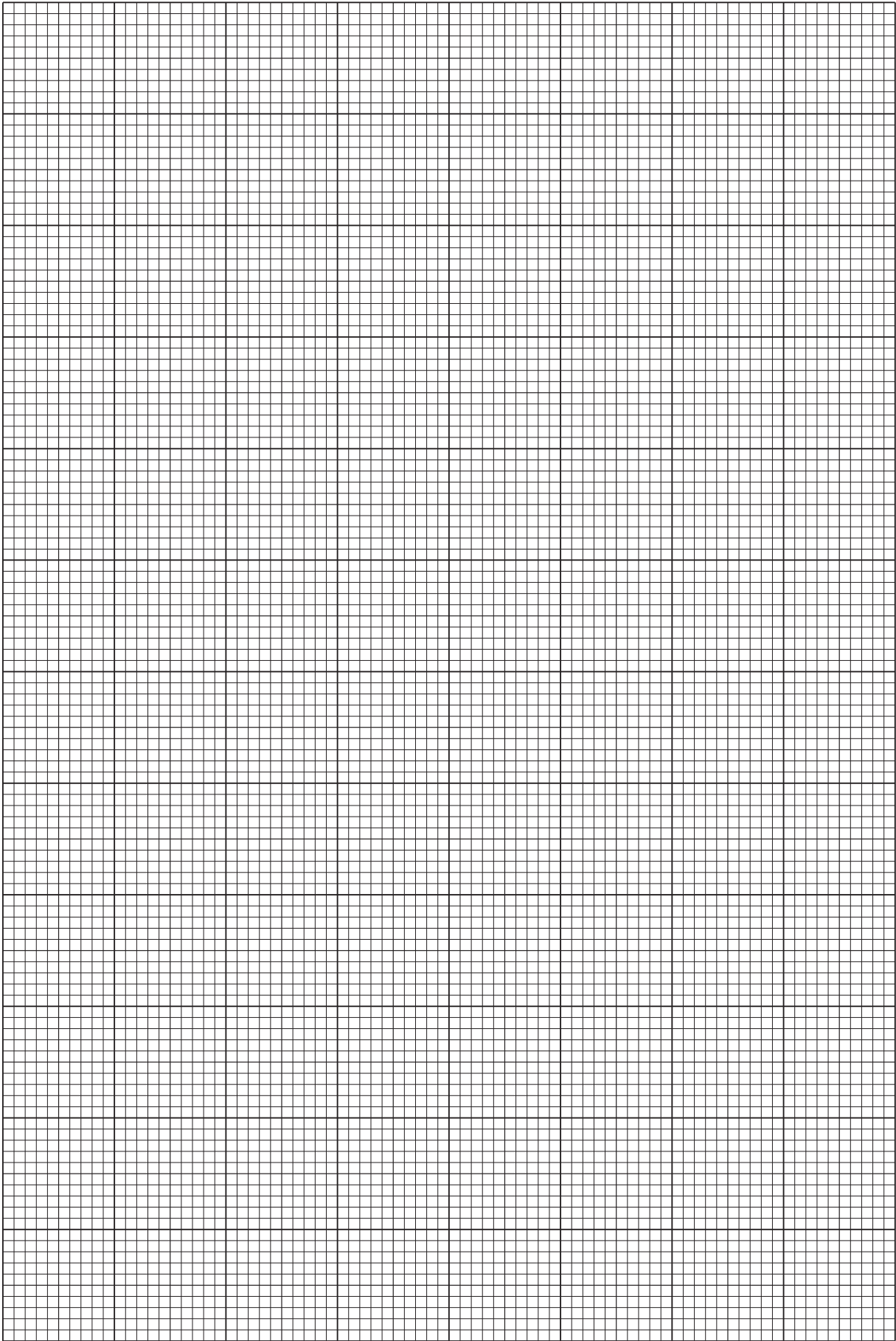
- (b)
- Move M along the strip and adjust the apparatus so that the strip is parallel to the bench.
  - Measure  $L$  and determine  $T$ .
  - Repeat until you have six sets of values of  $L$  and  $T$ .  
Record your results in a table. Include values of  $L^2$  and  $T^2$  in your table.

- (c)
- (i) Plot a graph of  $T^2$  on the  $y$ -axis against  $L^2$  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]



(d) It is suggested that the quantities  $T$  and  $L$  are related by the equation

$$T^2 = aL^2 + b$$

where  $a$  and  $b$  are constants.

Use your answers in (c)(iii) to determine the values of  $a$  and  $b$ .  
Give appropriate units.

$a =$  .....

$b =$  .....

[2]

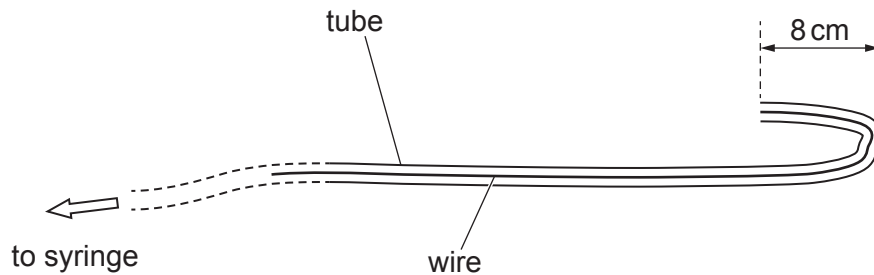
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**You may not need to use all of the materials provided.**

**2** In this experiment, you will investigate the amount of air needed to lift an underwater load.

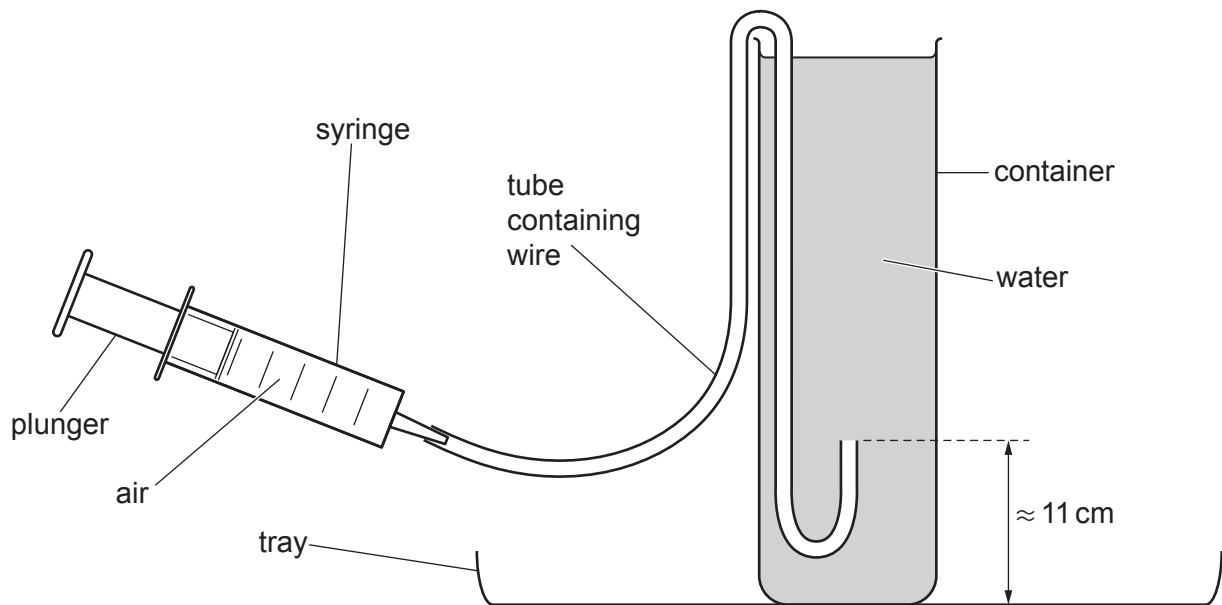
**(a)** You are provided with a syringe attached to a long tube containing a wire.

- Bend the end of the tube as shown in Fig. 2.1.



**Fig. 2.1**

- Pull the plunger of the syringe to the  $50\text{ cm}^3$  mark ( $1\text{ cm}^3 = 1\text{ ml}$ ).
- Bend the tube and hook it over the container so that the end is approximately 11 cm above the bottom of the container, as shown in Fig. 2.2.



**Fig. 2.2**

- (i) You have been provided with a set of metal rings.

Take measurements to determine the average thickness  $t$  of the rings.  
Show your working.

$t = \dots\dots\dots$  cm [1]

- (ii) Measure and record the inner diameter  $d_1$  and the outer diameter  $d_2$  of one of the metal rings, as shown in Fig. 2.3.

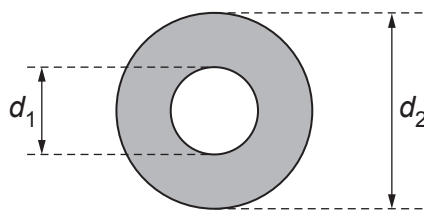


Fig. 2.3

$d_1 = \dots\dots\dots$  cm

$d_2 = \dots\dots\dots$  cm  
[1]

- (iii) Calculate the volume  $V_R$  of a metal ring using

$$V_R = \frac{\pi t(d_2^2 - d_1^2)}{4}.$$

$V_R = \dots\dots\dots$  cm<sup>3</sup> [1]

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

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



(b) You have been provided with a paper clip and a plastic cup with string attached.

- (i) • Bend the paper clip into a hook shape as shown in Fig. 2.4. Add 8 metal rings to the paper clip and hook it onto the string loop, as shown in Fig. 2.4.

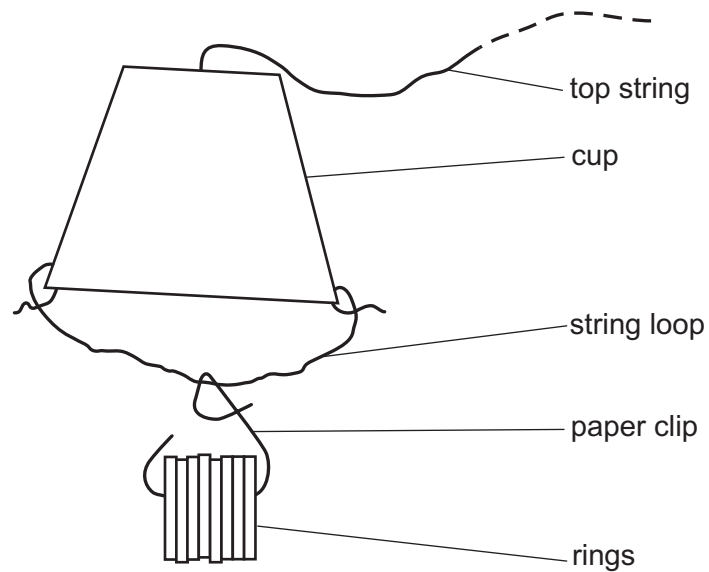


Fig. 2.4

- Lower the cup into the water. Ensure that the cup is **completely** filled with water.
- Use the top string to position the cup over the end of the tube, as shown in Fig. 2.5.

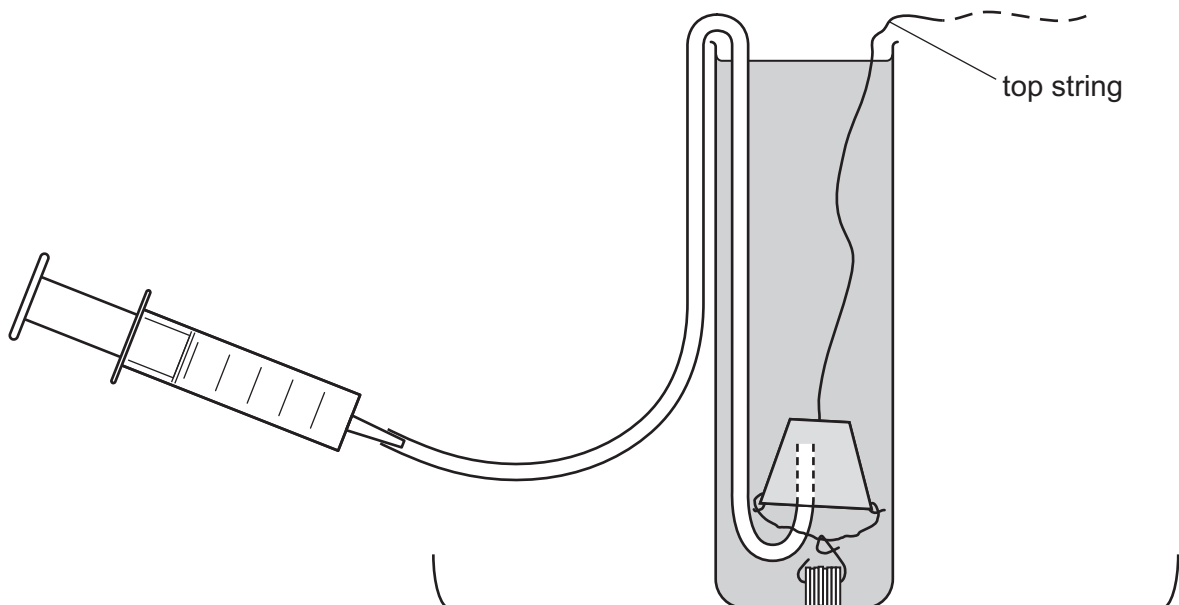


Fig. 2.5

- Record the initial reading  $x_1$  from the syringe scale.

$$x_1 = \dots\dots\dots \text{cm}^3 \quad [1]$$

- (ii)
- Slowly press the plunger of the syringe so that air enters the cup. Continue until the cup starts to lift the rings towards the surface of the water.
  - Record the final reading  $x_2$  from the syringe scale.

$$x_2 = \dots\dots\dots \text{cm}^3$$

- Calculate the volume of air  $V_A$  in the cup using

$$V_A = x_1 - x_2.$$

$$V_A = \dots\dots\dots \text{cm}^3$$

[2]

- (iii) Estimate the percentage uncertainty in your value of  $V_A$ . Show your working.

percentage uncertainty =  $\dots\dots\dots$  [1]

- (c)
- Remove the cup and the tube from the container of water.
  - Pull the plunger of the syringe to the 50 cm<sup>3</sup> mark to draw air into the syringe.
  - Replace the tube in the container of water.
  - Repeat **(b)(i)** and **(b)(ii)** using 12 metal rings.

$$x_1 = \dots\dots\dots \text{ cm}^3$$

$$x_2 = \dots\dots\dots \text{ cm}^3$$

$$V_A = \dots\dots\dots \text{ cm}^3$$

[2]

(d) (i) The mass  $M$  of one metal ring is given on the card.

- Write down the value of  $M$ .

$M = \dots\dots\dots$  g

- The number of rings attached to the paper clip is  $n$ .  
It is suggested that the relationship between  $n$ ,  $M$ ,  $V_R$  and  $V_A$  is

$$nM = k(nV_R + V_A)$$

where  $k$  is a constant.

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

first value of  $k = \dots\dots\dots$

second value of  $k = \dots\dots\dots$

[1]

(ii) Explain whether your results support the suggested relationship.

.....

.....

.....

..... [1]

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

- 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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