



# Cambridge International AS & A Level

CANDIDATE  
NAME

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CENTRE  
NUMBER

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**PHYSICS**

**9702/33**

Paper 3 Advanced Practical Skills 1

**October/November 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 **16** pages. Any blank pages are indicated.

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

1 In this experiment, you will determine the resistivity of a metal.

- (a) • Set up the circuit shown in Fig. 1.1.

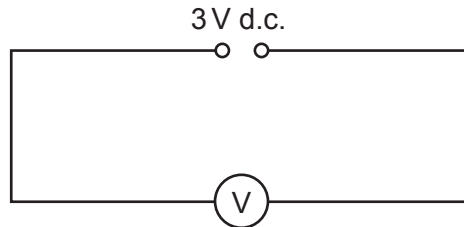


Fig. 1.1

- Record the voltmeter reading  $E$ .

$$E = \dots\dots\dots V$$

- Set up the circuit shown in Fig. 1.2.

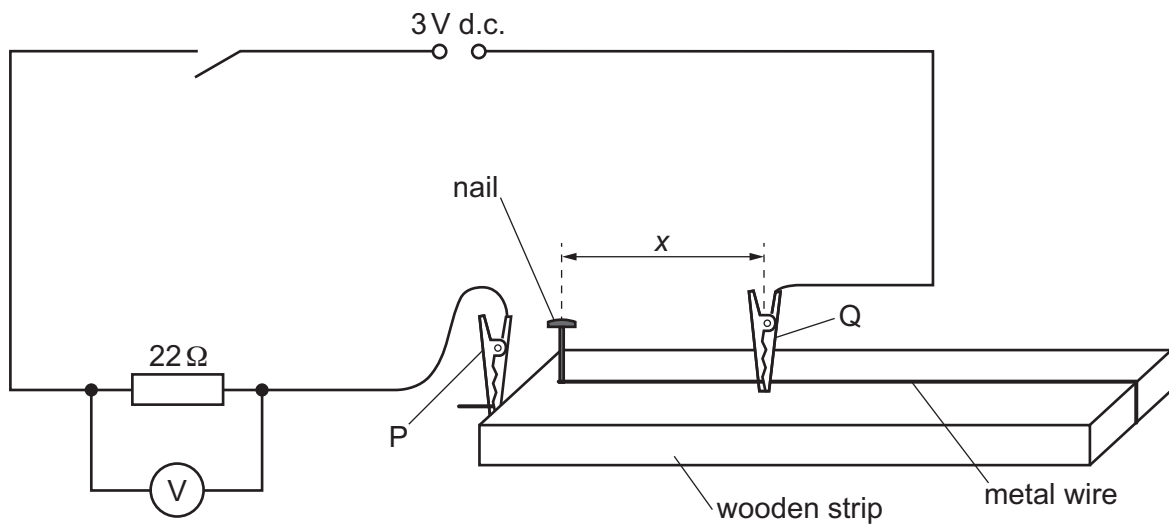


Fig. 1.2 (not to scale)

- P and Q are crocodile clips.

The distance between the nail and Q is  $x$ , as shown in Fig. 1.2.

Adjust the position of Q until  $x$  is approximately 45 cm.

- Close the switch.
- The voltmeter reading is  $V$ .

Measure and record  $x$  and  $V$ .

$x =$  .....

$V =$  .....

- Open the switch.

[1]

- (b) Change  $x$  by adjusting the position of Q on the wire. Use six different values of  $x$ . For each value of  $x$ , measure  $V$ .

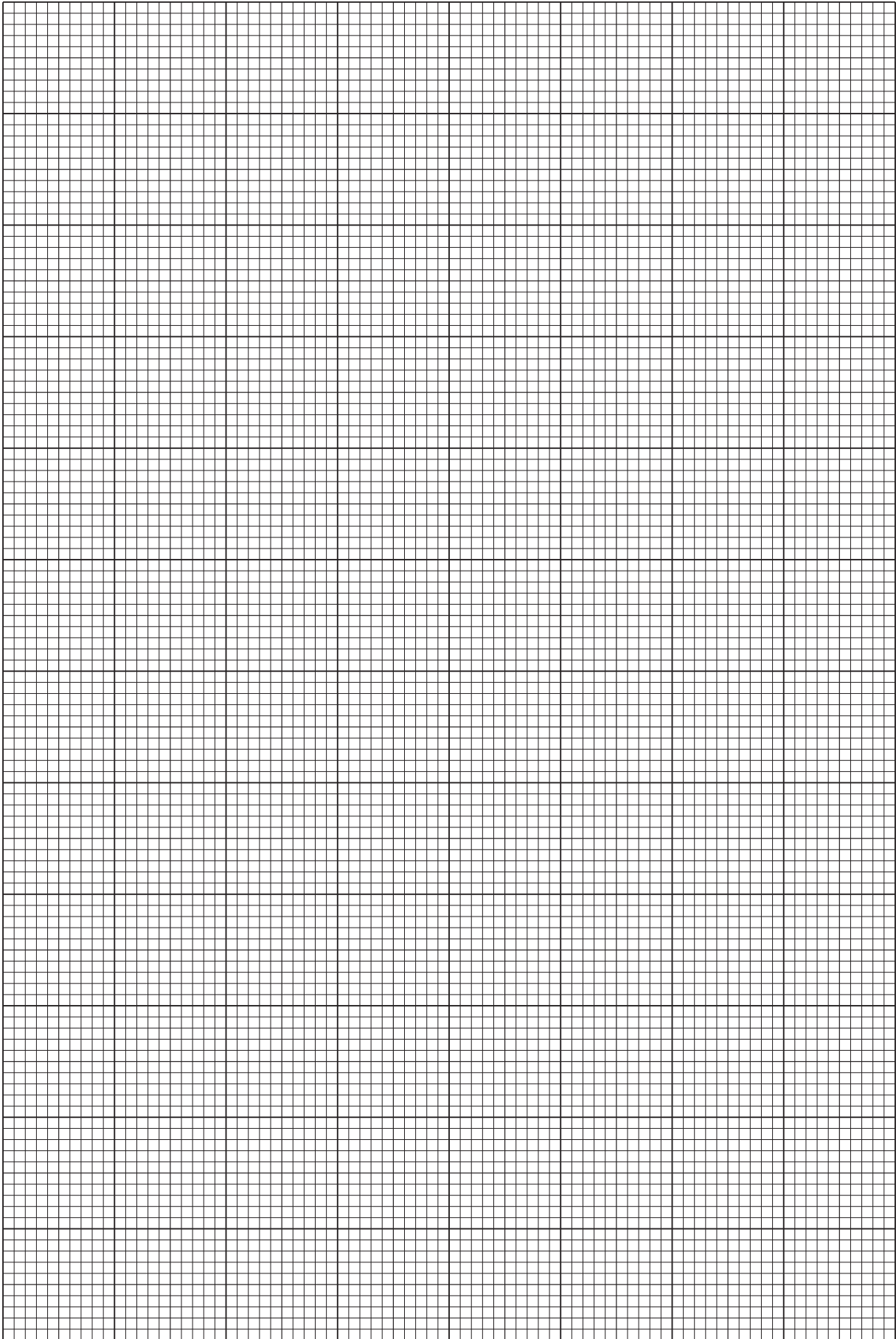
Record your results in a table. Include values of  $\frac{1}{V}$  in your table.

- (c) (i) Plot a graph of  $\frac{1}{V}$  on the  $y$ -axis against  $x$  on the  $x$ -axis. [8]
- (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  $V$  and  $x$  are related by the equation

$$\frac{1}{V} = Ax + B$$

where  $A$  and  $B$  are constants.

Using your answers in (c)(iii), determine the values of  $A$  and  $B$ .

Give appropriate units.

$A =$  .....

$B =$  .....

[1]

(e) (i) Use a micrometer to measure the diameter  $d$  of the wire.

$d =$  ..... [2]

(ii) It is suggested that  $A$  is given by the equation

$$A = -\frac{4\rho}{\pi d^2 ER}$$

where  $R$  is  $22\Omega$  and  $\rho$  is the resistivity of the metal.

Using your answers in (a), (d) and (e)(i), determine a value for  $\rho$ .

Give an appropriate unit.

$\rho =$  ..... [2]

[Total: 20]



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

2 In this experiment, you will investigate the extension of two springs.

(a) (i) • Set up the apparatus as shown in Fig. 2.1.

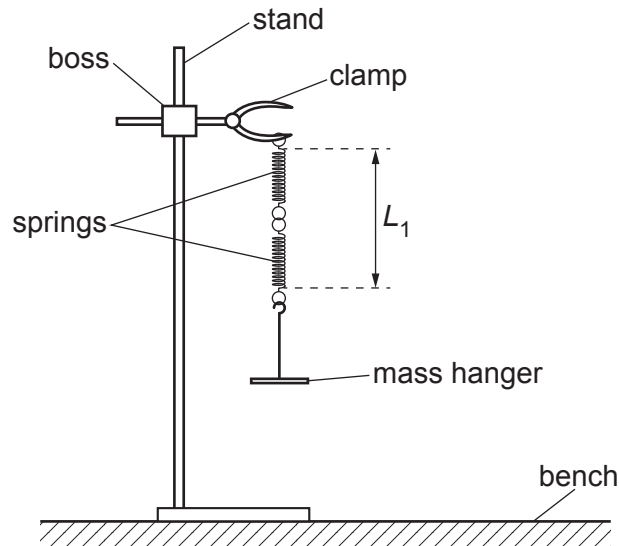


Fig. 2.1

- The length  $L_1$  of the spring combination is measured from the top coil of the top spring to the bottom coil of the bottom spring, as shown in Fig. 2.1.

Measure and record  $L_1$ .

$$L_1 = \dots\dots\dots [1]$$

(ii) Estimate the percentage uncertainty in your value of  $L_1$ . Show your working.

$$\text{percentage uncertainty} = \dots\dots\dots \% [1]$$

- (iii) • Add the slotted mass to the mass hanger.
- The new length of the spring combination is  $L_2$ .

Measure and record  $L_2$ .

$$L_2 = \dots\dots\dots$$



- The spring constant  $k$  is given by the equation

$$k = \frac{W}{(L_2 - L_1)}$$

where  $W$  is 0.981 N.

Calculate  $k$ .

$$k = \dots\dots\dots$$

- Remove the slotted mass and the mass hanger from the springs. [1]

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

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

- (b) (i) • Use the balance to measure and record the total mass  $M$  of the four **smaller** steel nuts.

$$M = \dots\dots\dots$$

- The volume  $V$  of the four nuts is given by the equation

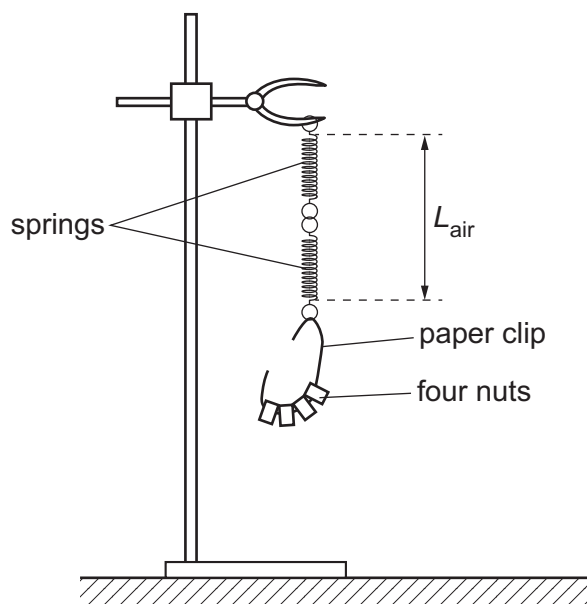
$$V = \frac{M}{\rho_{\text{steel}}}$$

where the density  $\rho_{\text{steel}}$  of steel is  $7.8 \text{ g cm}^{-3}$ .

Calculate  $V$ .

$$V = \dots\dots\dots [2]$$

- (ii) • Set up the apparatus using the four **smaller** nuts as shown in Fig. 2.2.



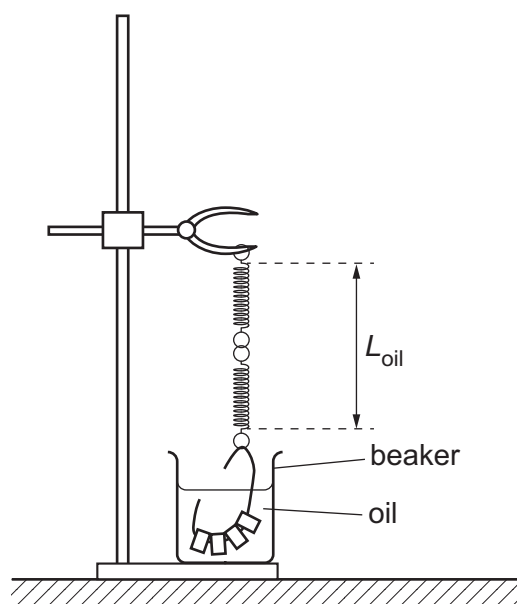
**Fig. 2.2**

- Bend the paper clip to hold the four nuts.
- The length of the spring combination is  $L_{\text{air}}$ .

Measure and record  $L_{\text{air}}$ .

$L_{\text{air}} = \dots\dots\dots$

- Gently lower the nuts into the oil until they are submerged but not touching the bottom of the beaker, as shown in Fig. 2.3.



**Fig. 2.3**

- The length of the spring combination is  $L_{\text{oil}}$ .

Measure and record  $L_{\text{oil}}$ .

$$L_{\text{oil}} = \dots\dots\dots$$

- Calculate  $(L_{\text{air}} - L_{\text{oil}})$ .

$$(L_{\text{air}} - L_{\text{oil}}) = \dots\dots\dots$$

- Remove the four nuts from the oil and place them on the tissue in the container.

[1]

(iii) Repeat (b)(i) and (b)(ii) with the four **larger** steel nuts.

$$M = \dots\dots\dots$$

$$V = \dots\dots\dots$$

$$L_{\text{air}} = \dots\dots\dots$$

$$L_{\text{oil}} = \dots\dots\dots$$

$$(L_{\text{air}} - L_{\text{oil}}) = \dots\dots\dots$$

[2]

- (c) It is suggested that the relationship between  $L_{\text{air}}$ ,  $L_{\text{oil}}$  and  $V$  is

$$(L_{\text{air}} - L_{\text{oil}}) = ZV$$

where  $Z$  is a constant.

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

first value of  $Z = \dots\dots\dots$

second value of  $Z = \dots\dots\dots$

[1]

- (d) It is suggested that the percentage uncertainty in the values of  $Z$  is 5%.

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

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

(e) The density  $\rho_{\text{oil}}$  of the oil is related to  $Z$  by

$$Z = \frac{\rho_{\text{oil}}g}{k}$$

where  $g$  is  $9.81 \text{ N kg}^{-1}$ .

Use your second value of  $Z$  to determine  $\rho_{\text{oil}}$ . Give an appropriate unit.

$$\rho_{\text{oil}} = \dots\dots\dots [1]$$

(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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