Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **May/June 2024**

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 an electrical circuit.

You have been provided with a metre rule with a wire attached. You have also been provided with six identical resistors. Four of the resistors are connected in series and attached to a wooden block. The other resistors are labelled X and Z.

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

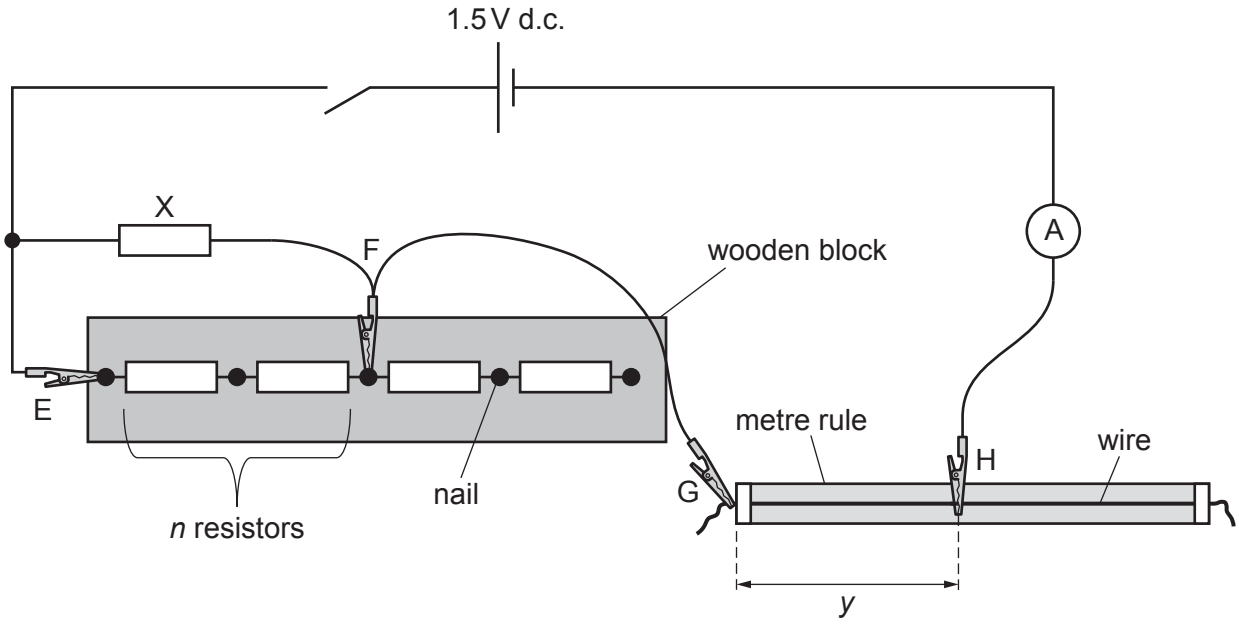


Fig. 1.1 (not to scale)

- E, F, G and H are crocodile clips.

  n resistors on the wooden block are connected in parallel with X. Connect F so that *n* = 2, as shown in Fig. 1.1.

- The distance between G and H is *y*. Attach H to the wire so that *y* is approximately 50 cm.

- Close the switch.

- Record *n*, *y* and the ammeter reading I.

  n = ...

  y = ...

  I = ...

- Open the switch.

[2]

(b) ● Connect Z as shown in Fig. 1.2.

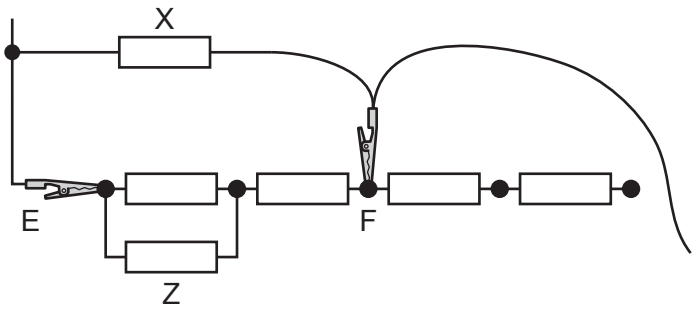


Fig. 1.2

When Z is connected in parallel with the first of the resistors on the block, the total value of *n* is reduced by 0.5.

For the arrangement in Fig. 1.2, the value of *n* is 1.5.

- Close the switch.
- Change the position of H on the wire until the value of I is as close as possible to your value in **(a)**.
- Record *n* and *y*.

n = ...

y = ...

- Open the switch.
- Disconnect Z.

[1]

[Turn over

(c) Vary n by changing the position of F and connecting and disconnecting Z.

For each value of n, change the position of H until the value of I is as close as possible to your value in **(a)**.

Repeat until you have six sets of values of n and y. Include your values from **(a)** and **(b)**.

Record your results in a table. Include values of $\frac{n}{n+1}$ to two significant figures in your table.

[8]

(d) (i) Plot a graph of y on the y-axis against $\frac{n}{n+1}$ on the x-axis. [3]

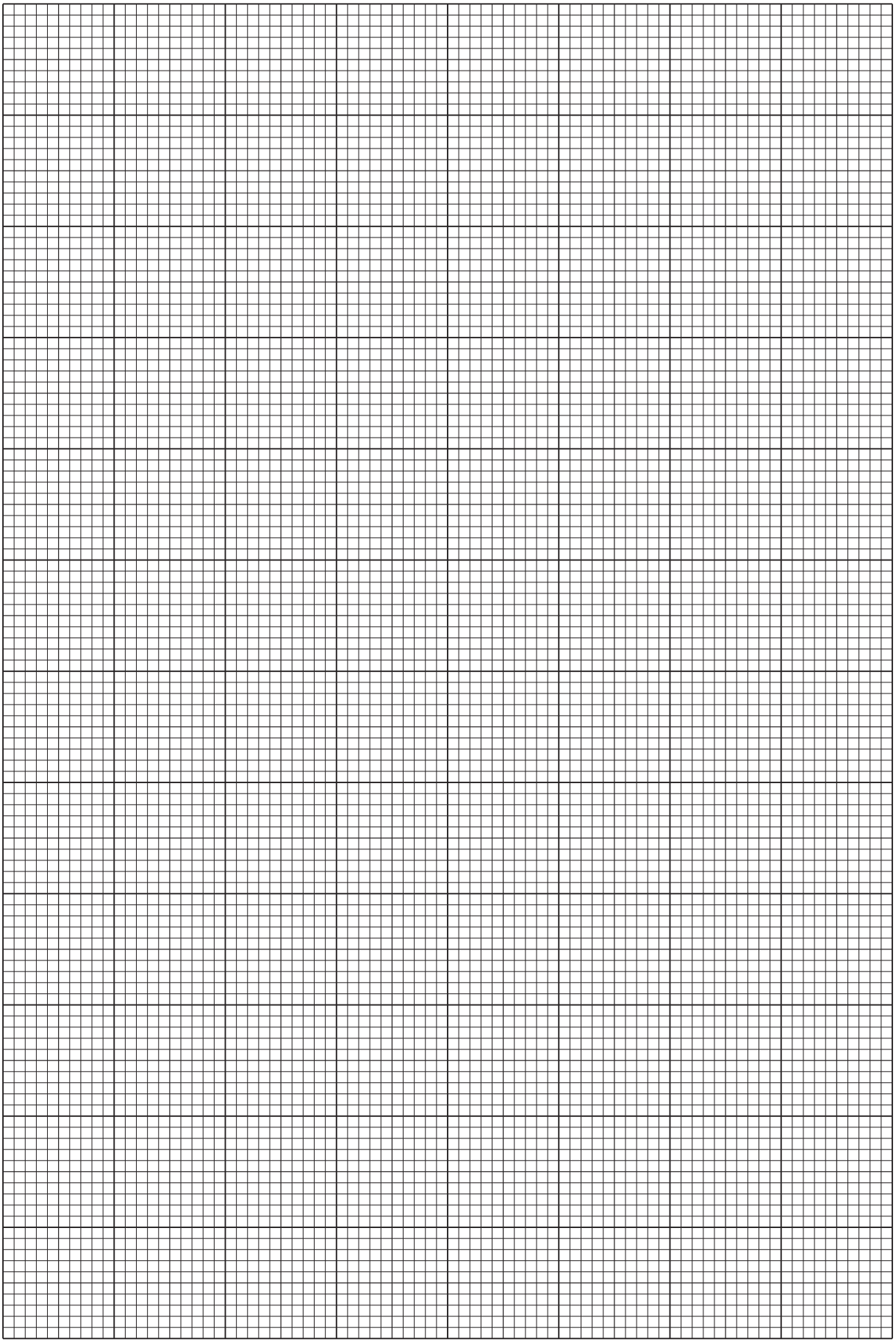
(ii) Draw the straight line of best fit. [1]

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

gradient = ...

y-intercept = ...

[2]



(e) It is suggested that the quantities y and n are related by the equation

$$y = -\frac{Pn}{n+1} + Q$$

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) Theory suggests that

$$\frac{P}{Q} = \frac{X}{C}$$

where the resistance X of resistor X is 12 Ω and C is the resistance of the whole circuit.

Use your values in **(e)** to determine a value for C.

C = ... Ω [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 rod.

(a) (i) The length of the rod is L, as shown in Fig. 2.1.

Fig. 2.1

Measure and record L.

L = ... [1]

(ii) The mass of the rod is M.

Measure and record M.

M = ... [1]

(iii) Calculate S, where

$$S = \frac{ML^2}{12}.$$

S = ... [1]

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

.....

.....

..... [1]

[Turn over

(b) (i) ● Wrap one end of the copper wire tightly three times around the centre of the rod, as shown in Fig. 2.2.

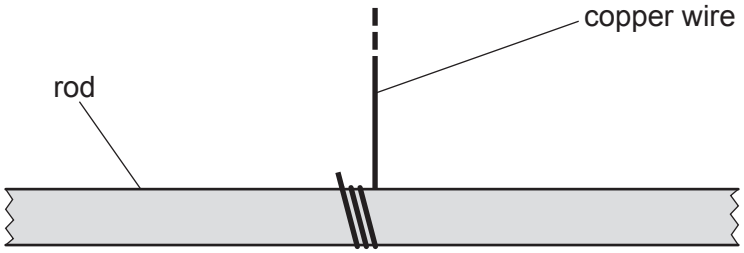


Fig. 2.2

● Slide a 50 g slotted mass onto each end of the rod.

● Record the mass *m* on **one** end of the rod.

m = ... g

● Adjust the positions of the masses so that they are equally spaced from the centre of the rod and their centres are approximately 3 cm apart, as shown in Fig. 2.3. You may need to use some of the adhesive putty to keep the masses in position.

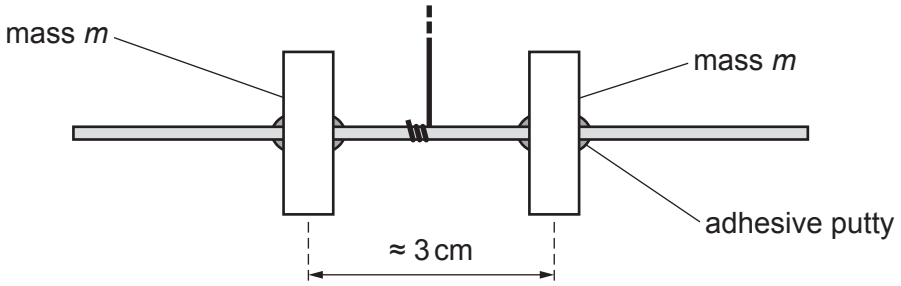


Fig. 2.3

- Set up the apparatus as shown in Fig. 2.4.

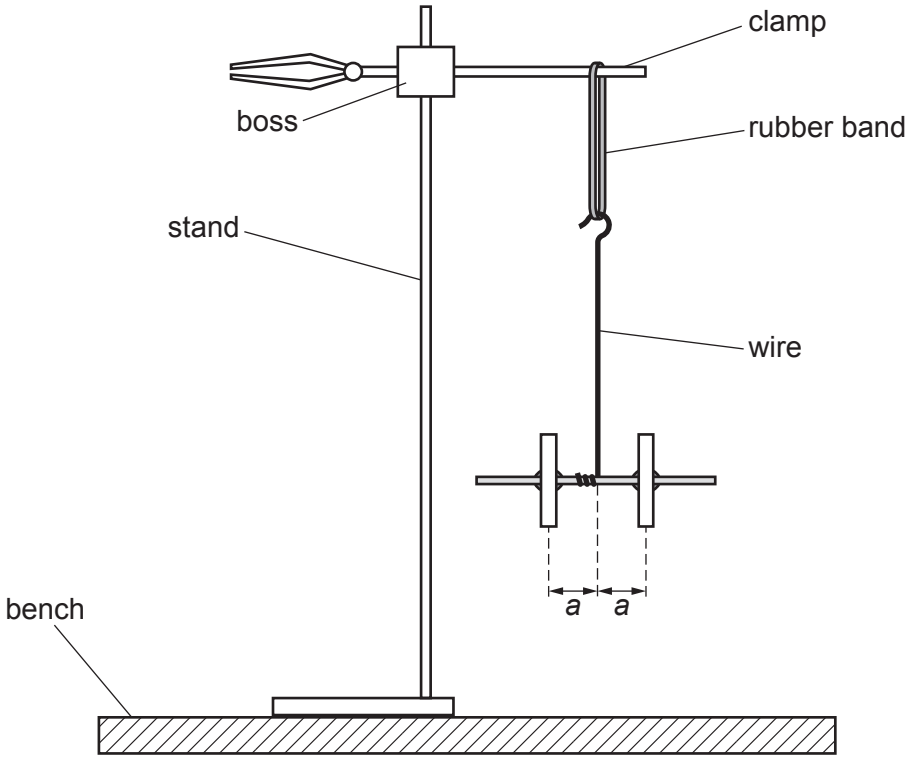


Fig. 2.4

- Make a hook in the wire and place the hook on the rubber band.
- The distance between the centre of each mass and the wire is *a*.

  Adjust the position of the masses until the rod is parallel to the bench and each mass is the same distance *a* from the wire.
- Measure and record *a*.

a = ...
[1]

(ii) Estimate the percentage uncertainty in your value of *a*. Show your working.

percentage uncertainty = ... % [1]

(c)
- Rotate the rod horizontally through 90°.
- Release the rod. The rod will oscillate.
- Take measurements to determine the period T of these oscillations.

T = ... [2]

(d)
- Remove the hook from the rubber band.
- Remove the 50 g masses from the rod.
- Place the 10 g masses on the rod so that their centres are approximately 9 cm apart.
- Record m.

m = ... g

- Place the hook on the rubber band.
- Adjust the position of the masses until the rod is parallel to the bench and each mass is the same distance a from the wire.
- Measure and record a.

a = ...

- Repeat **(c)**.

T = ...
[2]

(e) It is suggested that the relationship between T, S, a and m is

$$T^2 = k(S + a^2m)$$

where k is a constant.

Using your data, calculate two values of k.

first value of k = ...

second value of k = ...
[1]

(f) 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 **(e)**.

.....

.....

.....

..... [1]

(g) (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]