A

Surname ____________________

Other Names ____________________

Centre Number ____________________

Candidate Number ____________________

Candidate Signature ____________________

I declare this is my own work.

A-level
PHYSICS

Paper 3
Section A
7408/3A

Friday 5 June 2020 Afternoon

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

J U N 2 0 7 4 0 8 3 A 0 1

Time allowed: The total time for both sections of this paper is 2 hours. You are advised to spend approximately 70 minutes on this section.

For this paper you must have:
- **a pencil and a ruler**
- **a scientific calculator**
- **a Data and Formulae Booklet**

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write on blank pages.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**

- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

INFORMATION

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 45.
- You are expected to use a scientific calculator where appropriate.
- A Data and Formulae Booklet is provided as a loose insert.

DO NOT TURN OVER UNTIL TOLD TO DO SO

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SECTION A

Answer ALL questions in this section.

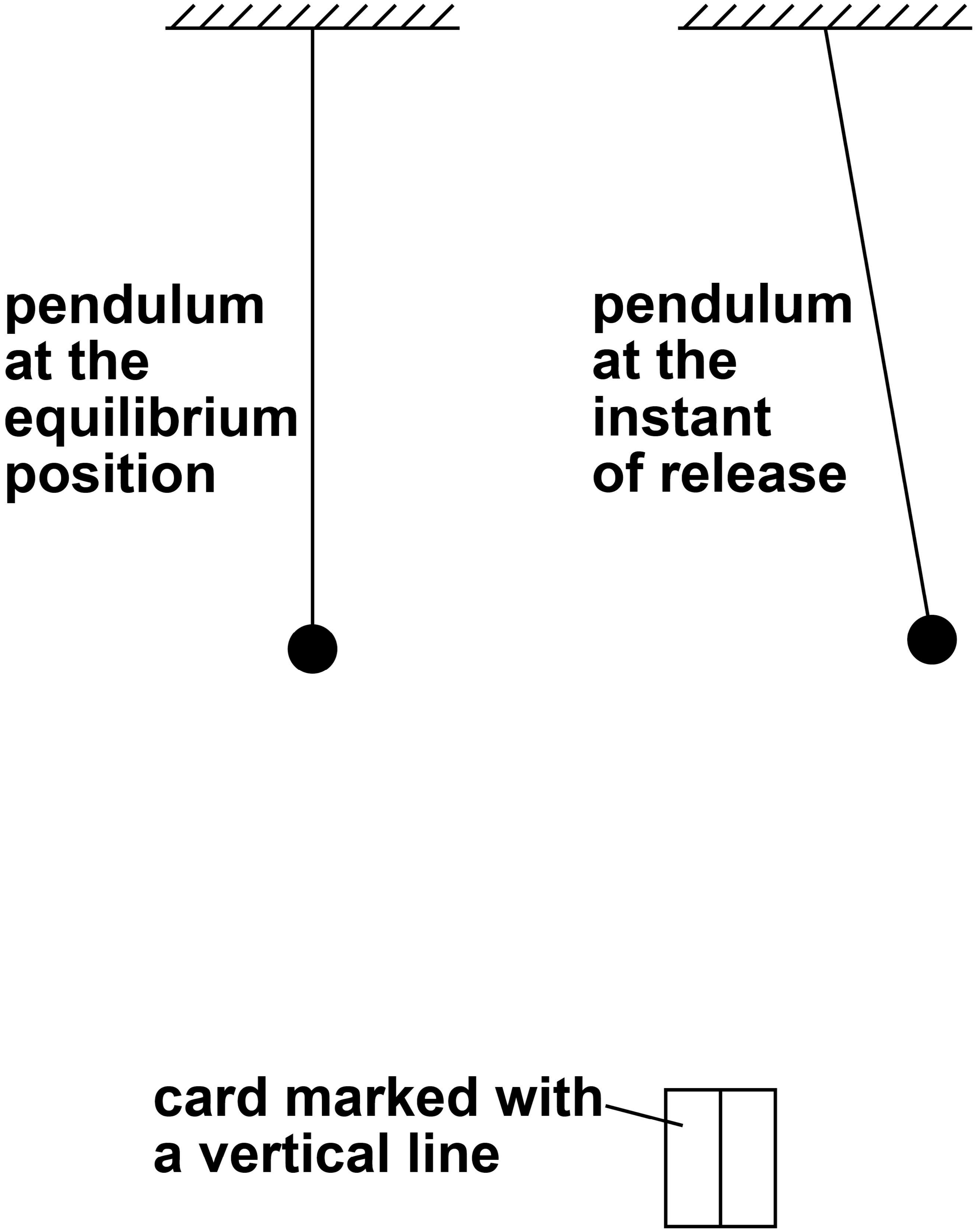
0 1

A simple pendulum performs oscillations of period T in a vertical plane.

FIGURE 1, on page 6, shows views of the pendulum at the equilibrium position and at the instant of release. FIGURE 1 also shows a rectangular card marked with a vertical line.

[Turn over]

FIGURE 1


pendulum
at the
equilibrium
position
pendulum
at the
instant
of release
card marked with
a vertical line

0 1 . 1

The card can be used as a fiducial mark to reduce uncertainty in the measurement of T.

Annotate FIGURE 1 to show a suitable position for the fiducial mark. Explain why you chose this position. [2 marks]

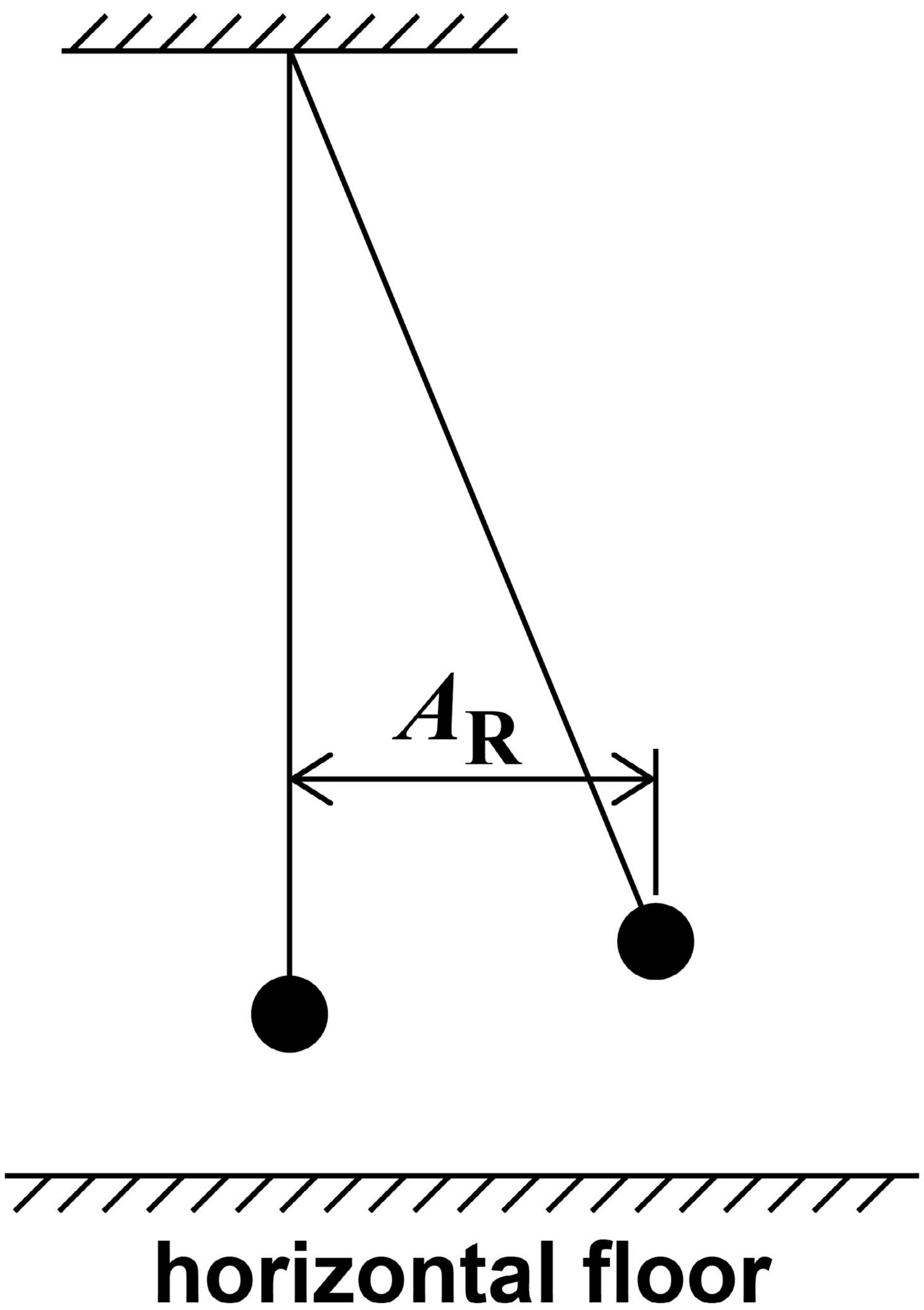
[Turn over]

0 1 . 2

The period of the pendulum is constant for small-amplitude oscillations.

FIGURE 2 shows an arrangement used to determine the maximum amplitude that can be considered to be small, by investigating how T varies with amplitude.

FIGURE 2



Describe a suitable procedure to determine A_{R}, the amplitude of the pendulum as it is released.

You may add detail to FIGURE 2, on the opposite page, to illustrate your answer.
[2 marks]

0 1 . 3

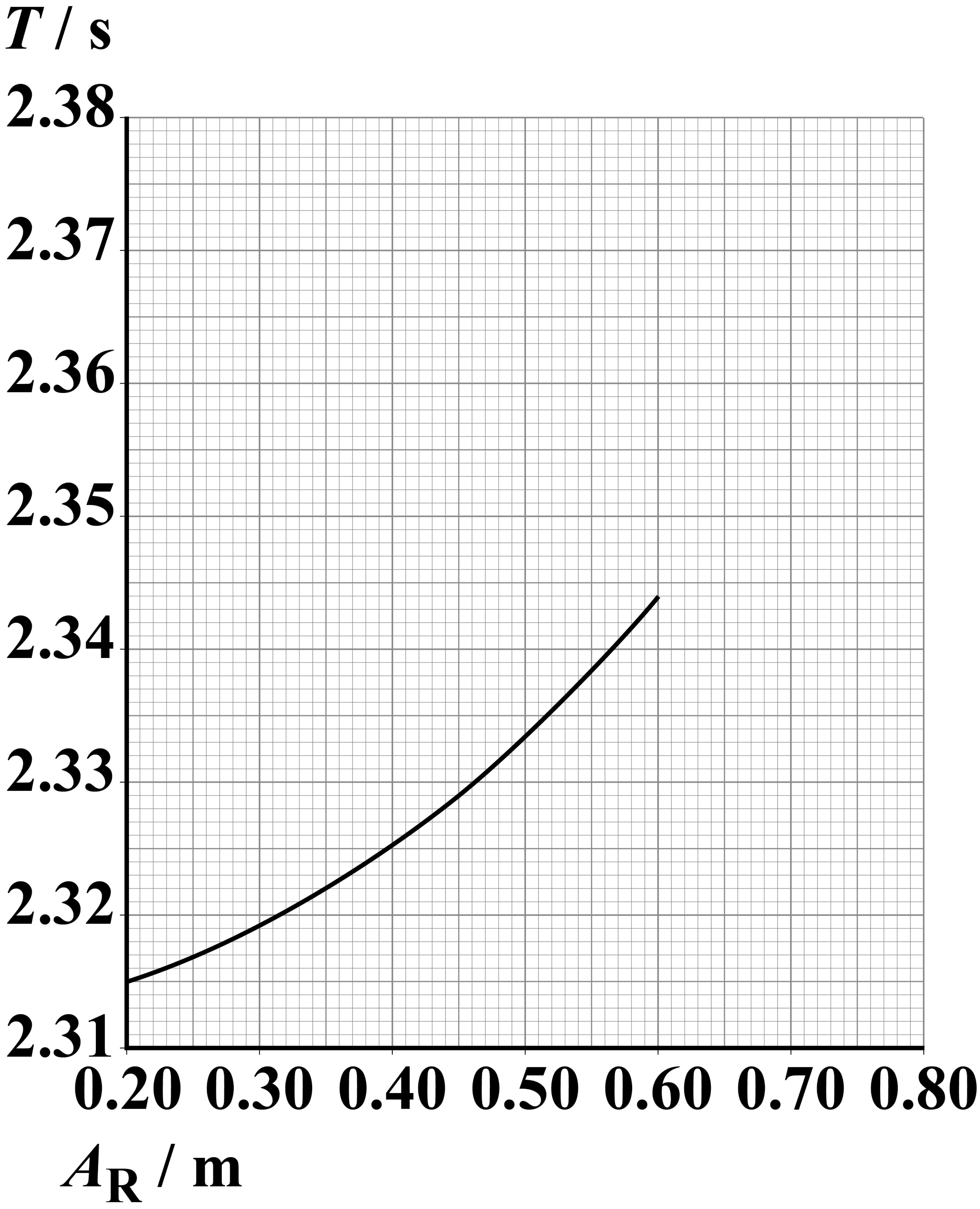
FIGURE 3, on the opposite page, shows some of the results of the experiment.

Estimate, using FIGURE 3, the expected percentage increase in T when A_R increases from 0.35 m to 0.70 m.

Show your working. [3 marks]

percentage increase = ________________ %

FIGURE 3



[Turn over]

In another experiment the pendulum is released from a fixed amplitude.

The amplitudes A_n of successive oscillations are recorded, where n = 1, 2, 3, 4, 5... .

TABLE 1 shows six sets of readings for the amplitude A_5.

TABLE 1

A_5 / m	0.217	0.247	0.225	0.223	0.218	0.224

01.4

Determine the result that should be recorded for A_5.

Go on to calculate the percentage uncertainty in this result. [3 marks]

A_5 = ____________________ m

percentage uncertainty = ______________ %

[Turn over]

0 1 . 5

TABLE 2 shows results for A_n and the corresponding value of $\ln(A_n / \mathrm{m})$ for certain values of n.

TABLE 2

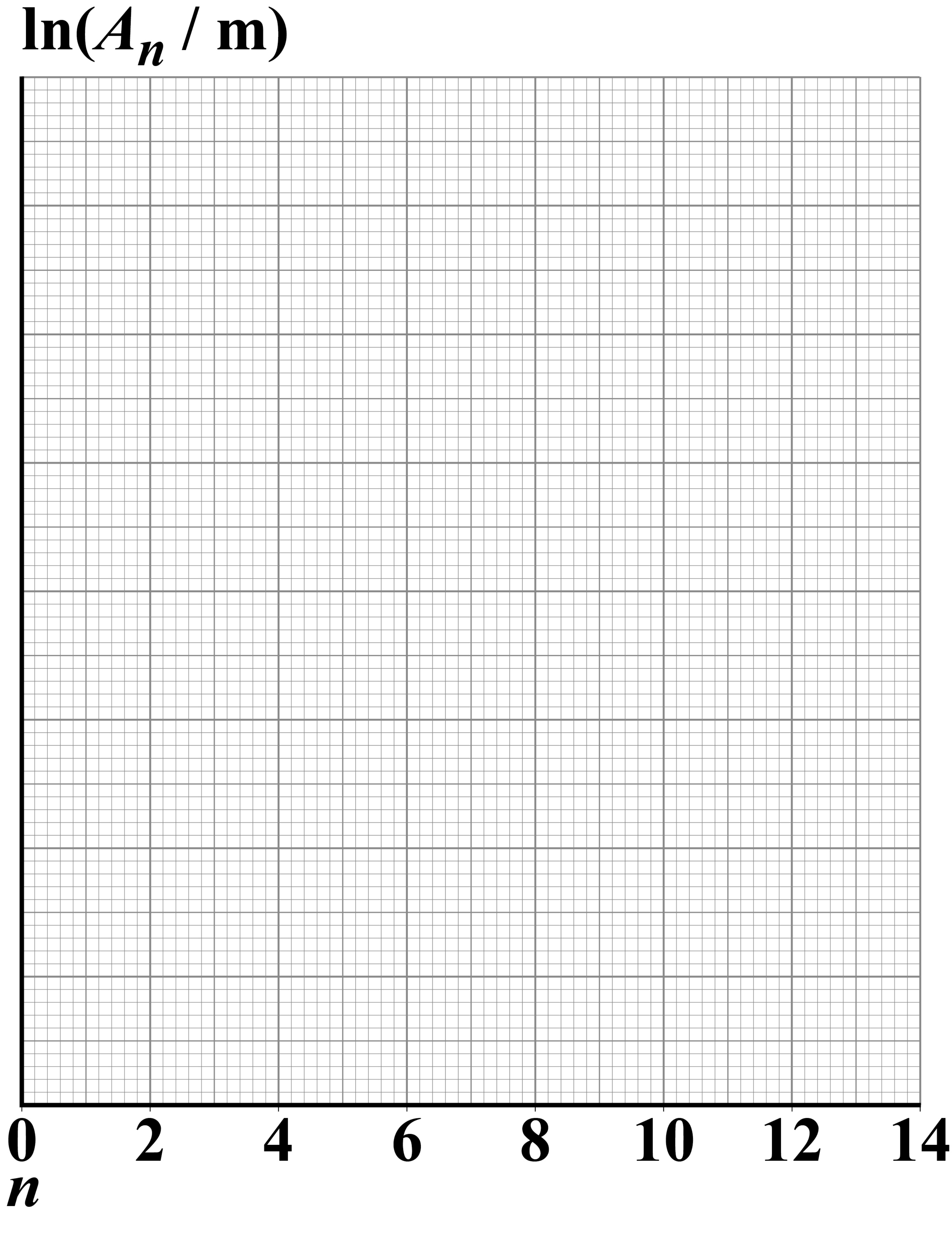
n	A_n / m	$\ln(A_n$ / m)
2	0.238	−1.435
4	0.225	
7	0.212	−1.551
10	0.194	−1.640
13	0.183	−1.698

Complete TABLE 2. [1 mark]

0 1 . 6

Plot on FIGURE 4, on the opposite page, a graph of $\ln(A_n / \mathrm{m})$ against n. [2 marks]

FIGURE 4



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0 1 . 7

It can be shown that

$A_n = A_0 \delta^{-n}$

where

A_0 **is the amplitude of release of the pendulum**
δ **is a constant called the damping factor.**

Explain how to find δ from your graph.
You are NOT required to determine δ.
[2 marks]

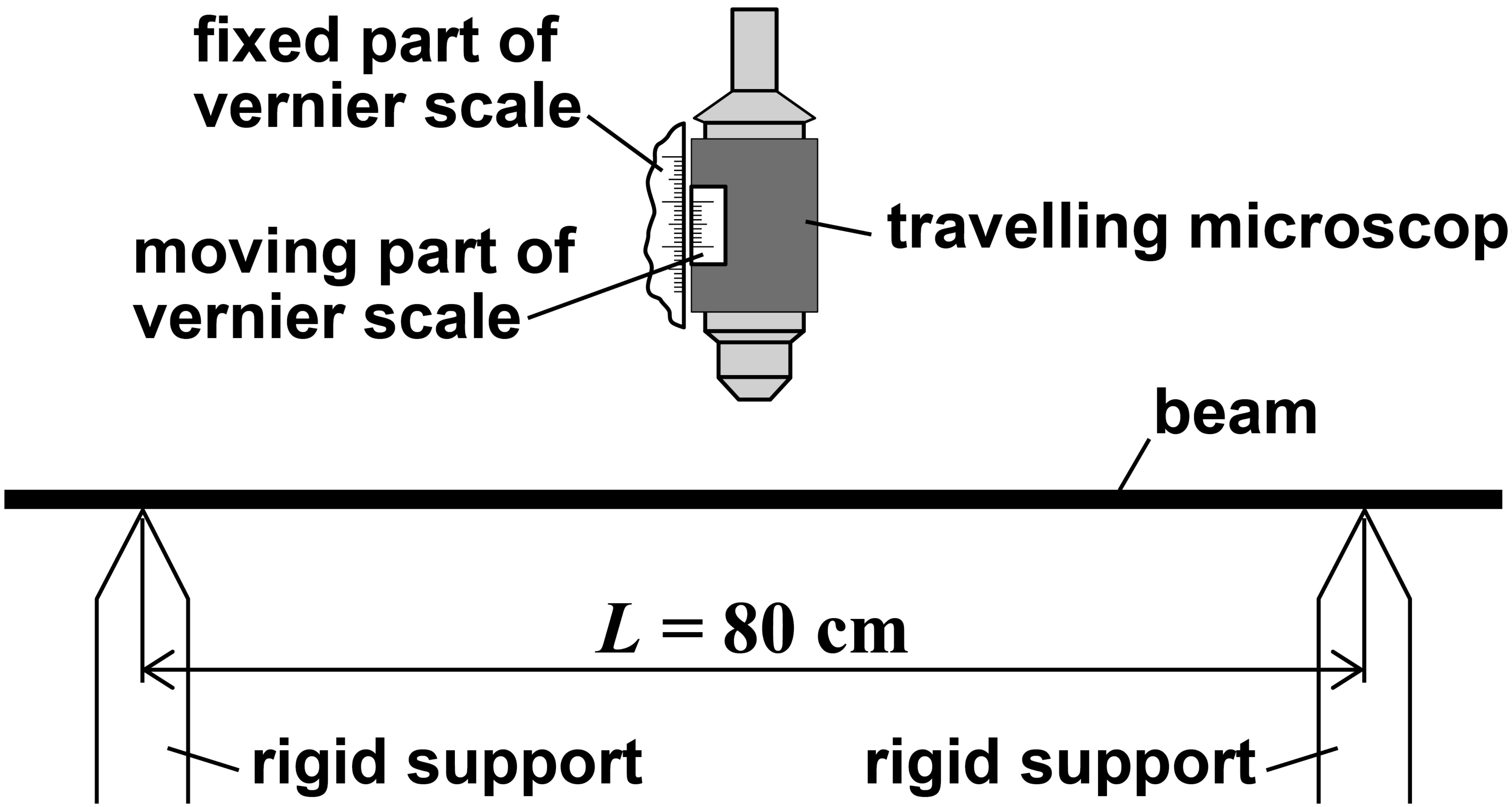
[Turn over]

15

0 2

FIGURE 5 shows apparatus used to investigate the bending of a beam.

FIGURE 5



The beam is placed horizontally on rigid supports. The distance L between the supports is $80\ \mathrm{cm}$.

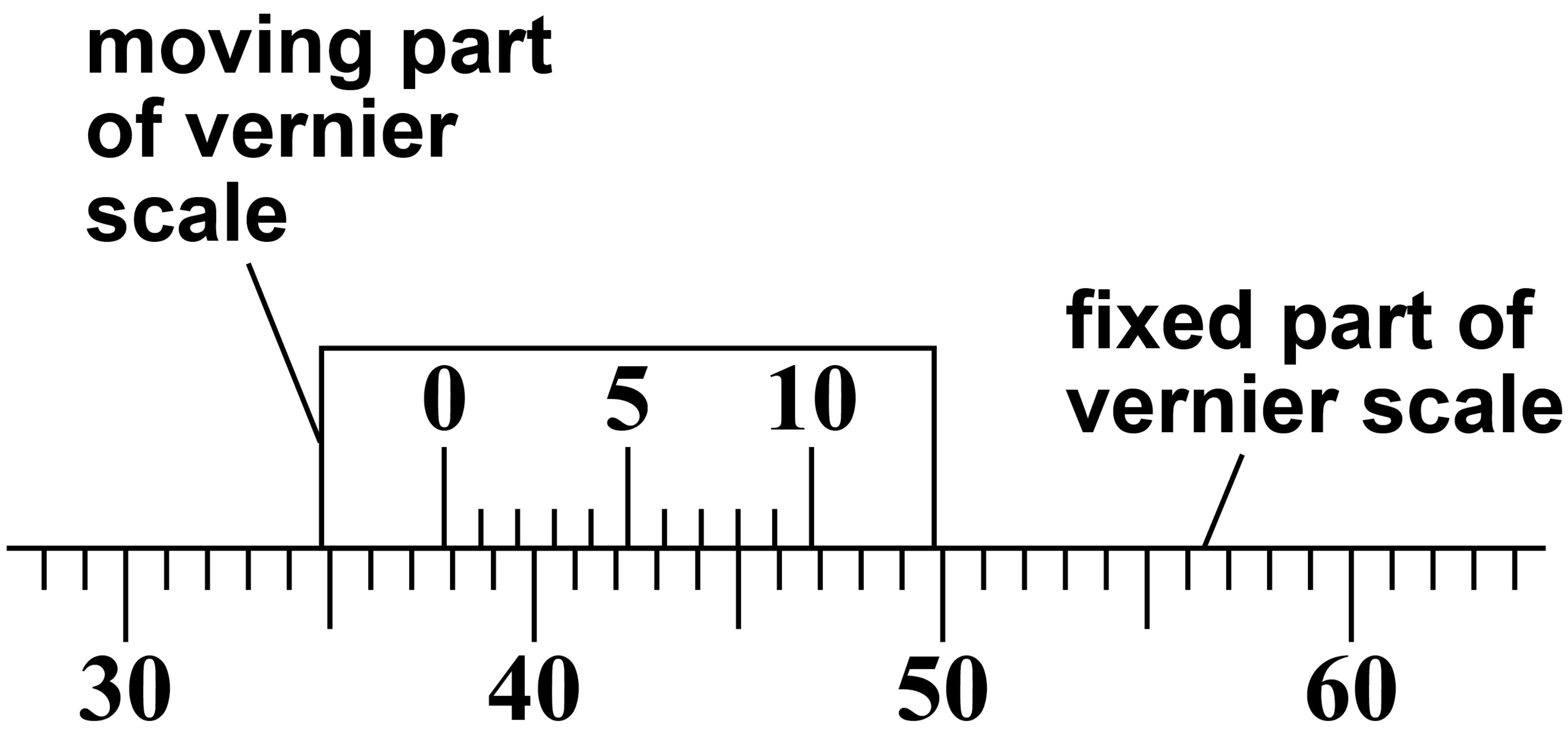
A travelling microscope is positioned above the midpoint of the beam and focused on the upper surface.

[Turn over]

0 2 . 1

FIGURE 6 shows an enlarged view of both parts of the vernier scale.

FIGURE 6



The smallest division on the fixed part of the scale is 1 mm.

What is the value of the vernier reading R_0 in mm?

Tick (✓) ONE box [1 mark]

☐ 34.8

☐ 37.8

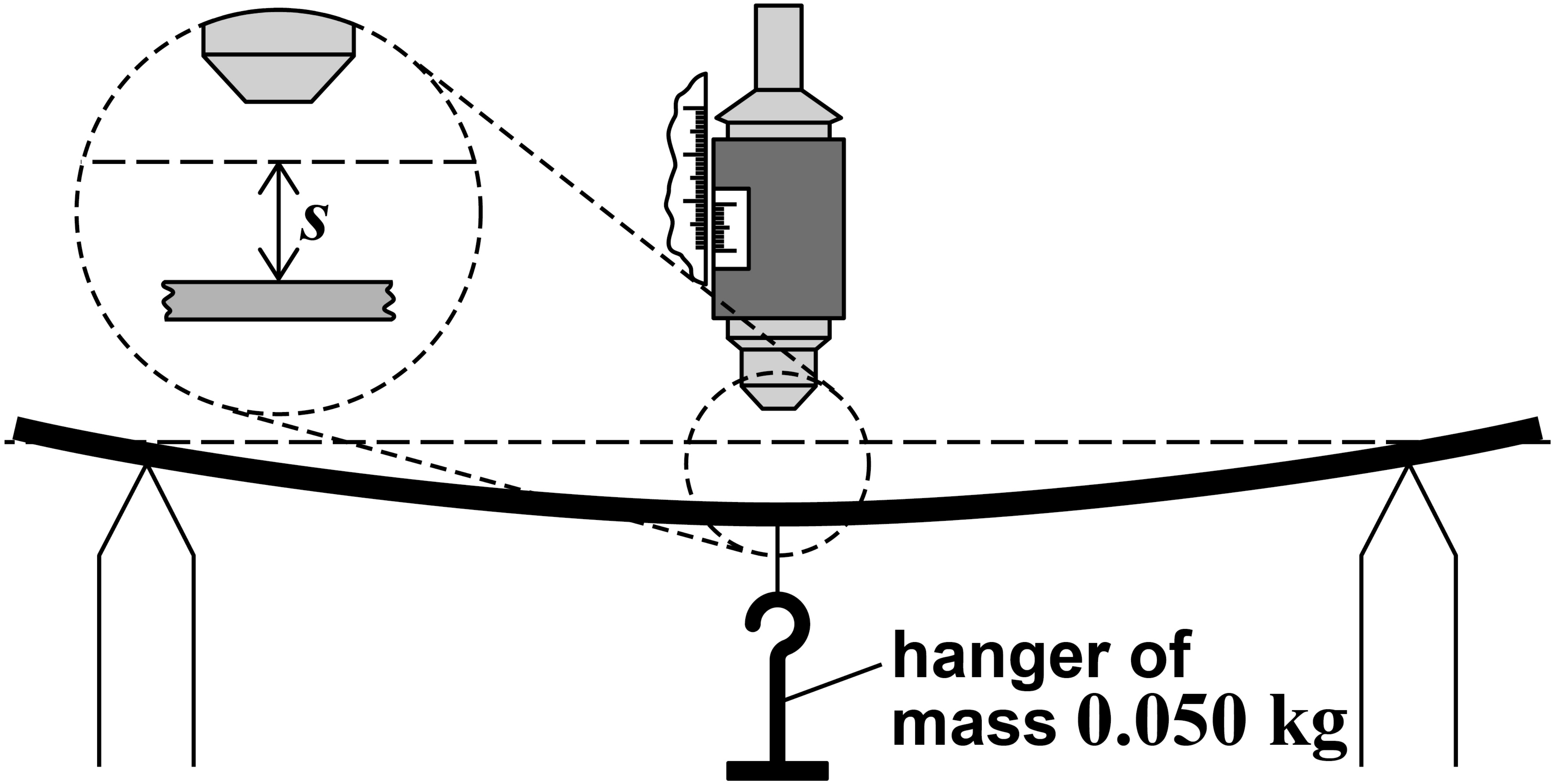
☐ 45.8

☐ 49.8

0 2 . 2

FIGURE 7 shows the beam bending when a hanger of mass 0.050 kg is suspended from the midpoint.

FIGURE 7



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[Turn over]

The microscope is refocused on the upper surface and the new vernier reading R is recorded. The vertical deflection s of the beam is equal to $(R - R_0)$.

The total mass m suspended from the beam is increased in steps of $0.050\ \mathrm{kg}$. A value of s is recorded for each m up to a value of $m = 0.450\ \mathrm{kg}$.

Further values of s are then recorded as m is decreased in $0.050\ \mathrm{kg}$ steps until m is zero.

Student A performs the experiment and observes that values of s during unloading are SOMETIMES different from the corresponding values for loading.

State the type of error that causes the differences student A observes. [1 mark]

[Turn over]

0 2 . 3

Student B performs the experiment using a thinner beam but with the same width and made from the same material as before.

Discuss ONE possible advantage and ONE possible disadvantage of using the thinner beam. [3 marks]

Advantage

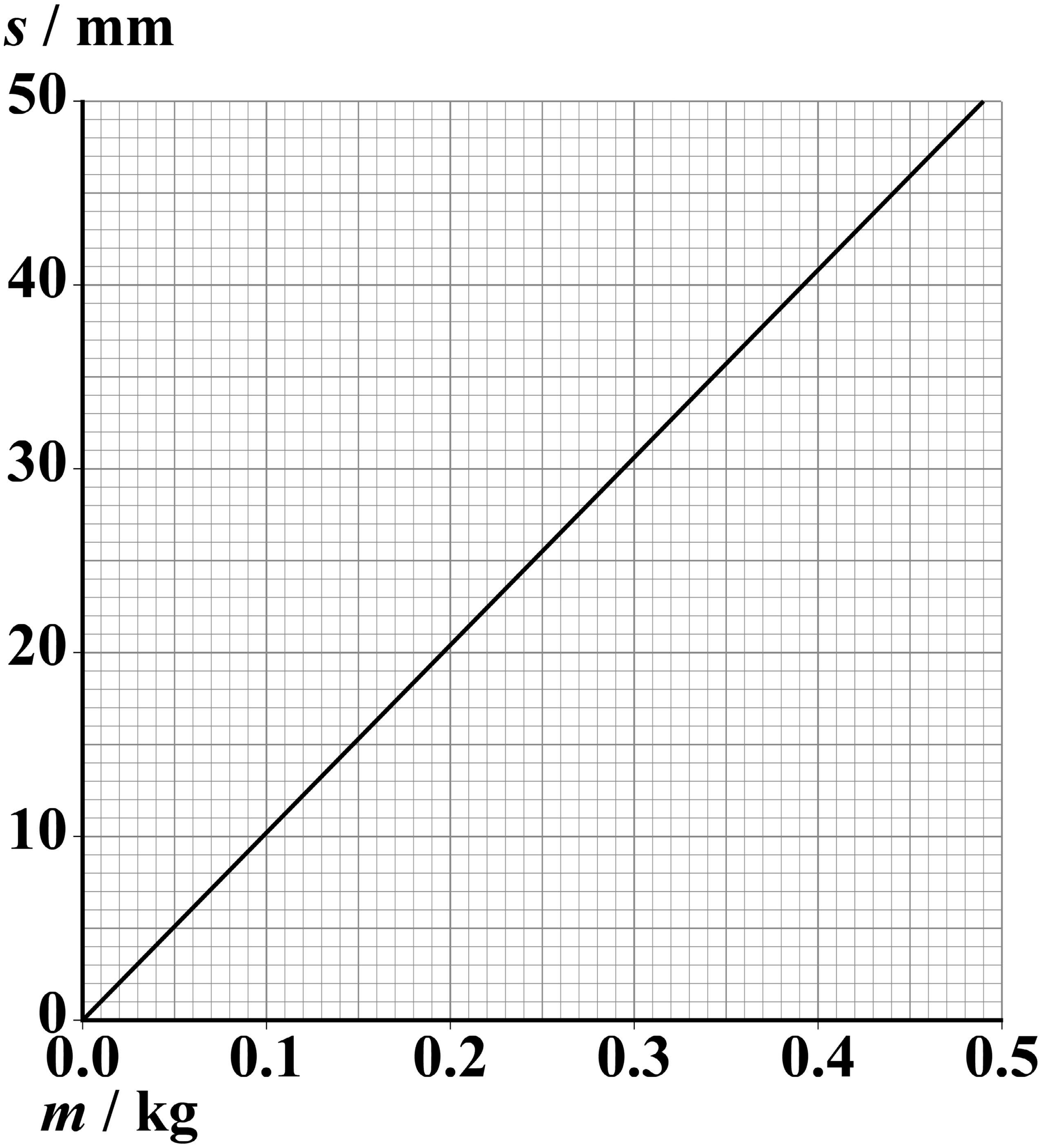
Disadvantage

[Turn over]

0 2 . 4

FIGURE 8 shows the best-fit line produced using the data collected by student A.

FIGURE 8



It can be shown that $s = \dfrac{\eta m}{E}$

where E is the Young modulus of the material of the beam and η is a constant.

Deduce in s^{-2} the order of magnitude of η.

$E = 1.14\ \mathrm{GPa}$

[4 marks]

order of magnitude of η = ______________ s^{-2}

0 2 . 5

Student C performs a different experiment using the same apparatus shown in FIGURE 5 on page 18.

A mass M is suspended from the midpoint of the beam. The vertical deflection s of the beam is measured for different values of L.

FIGURE 9, on page 32, shows a graph of the results for this experiment.

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FIGURE 9

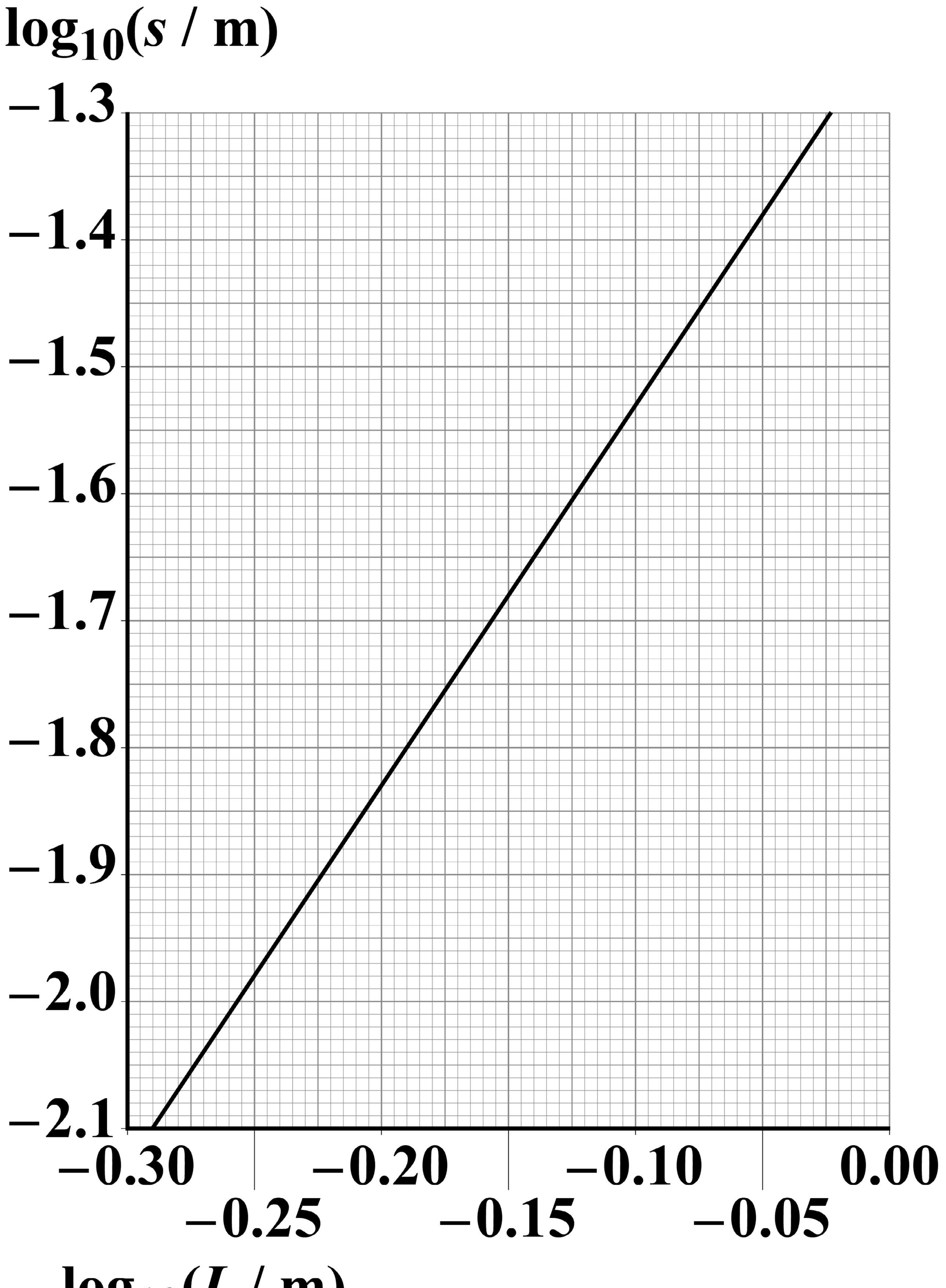
log10(s / m)
−1.3
−1.4
−1.5
−1.6
−1.7
−1.8
−1.9
−2.0
−2.1
−0.30
−0.25
−0.20
−0.15
−0.10
−0.05
0.00
log10(L / m)

FIGURE 9 shows that $\log_{10}(s\ /\ \mathrm{m})$ varies linearly with $\log_{10}(L\ /\ \mathrm{m})$.

State what this shows about the mathematical relationship between s and L. You do NOT need to do a calculation. [1 mark]

[Turn over]

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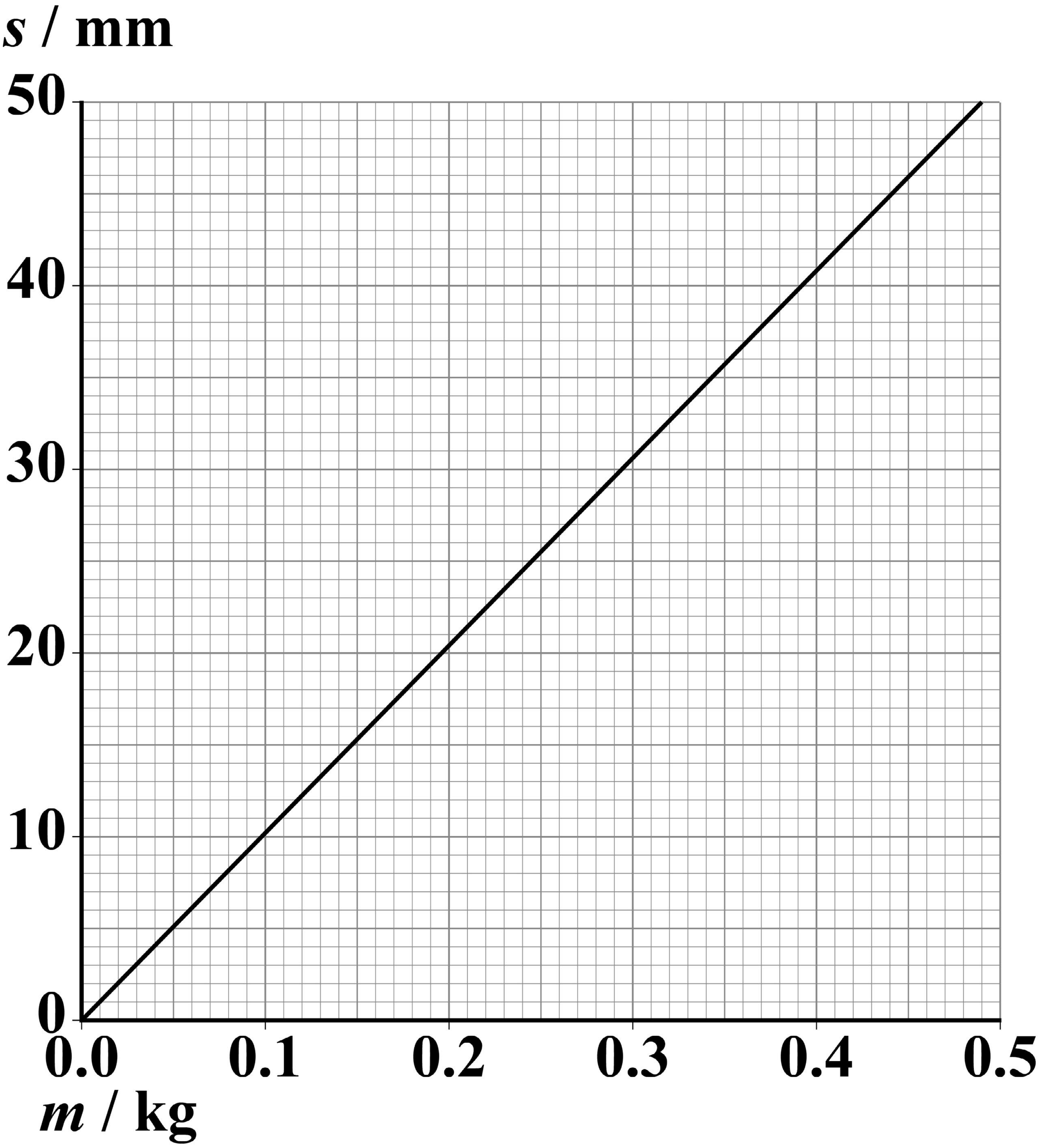
0 2 . 6

Deduce, using FIGURE 9 on page 32, the value of s when L = 80 cm. [2 marks]

s = ____________________________ m

[Turn over]

REPEAT OF FIGURE 8



0 2 . 7

Determine M using FIGURE 8. [1 mark]

M = ______________________________ kg

[Turn over]

13

0 3

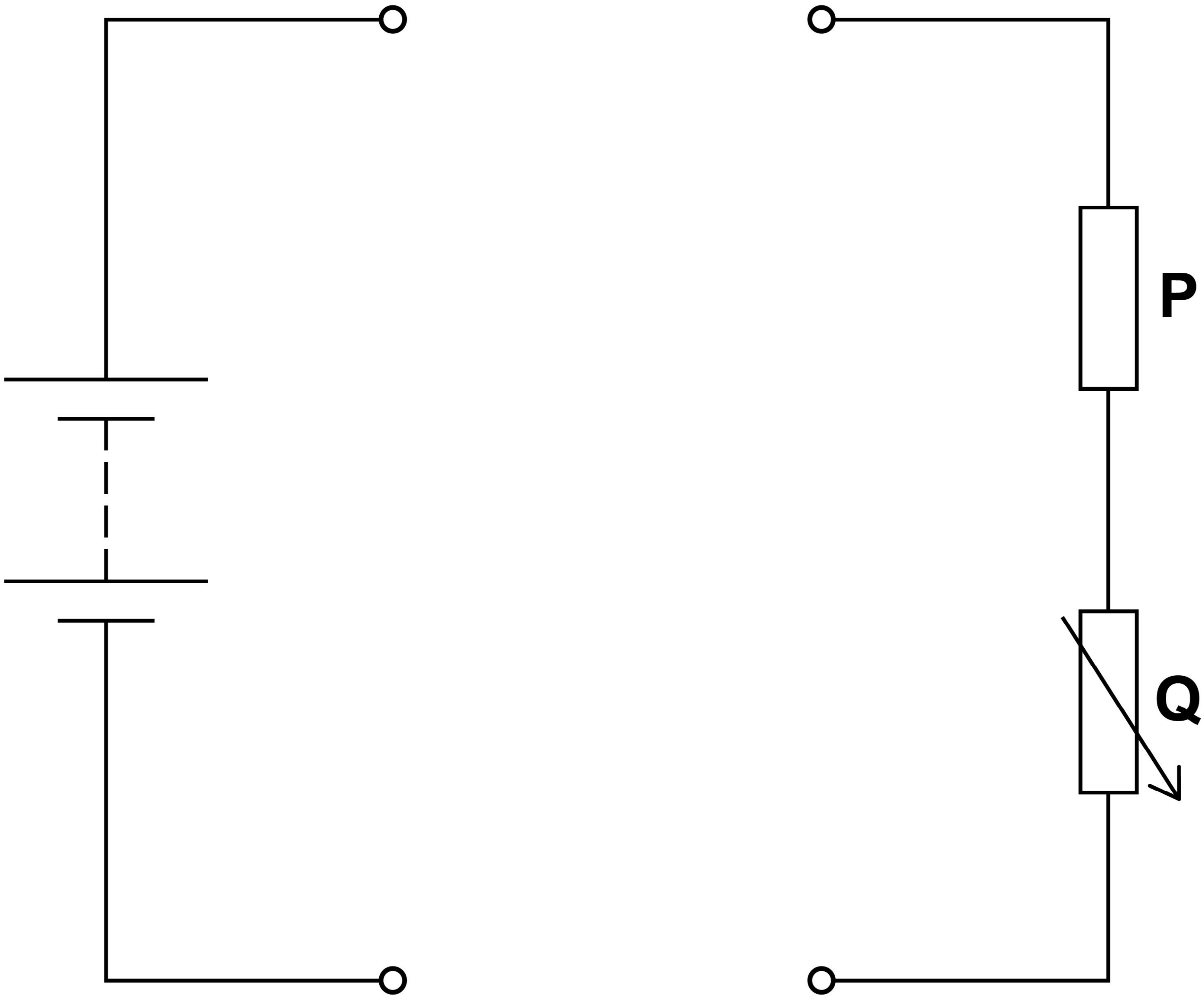
FIGURE 10, on the opposite page shows a partly-completed circuit used to investigate the emf ε and the internal resistance r of a power supply.

The resistance of P and the maximum resistance of Q are unknown.

0 3 . 1

Complete FIGURE 10, on the opposite page, to show a circuit including a voltmeter and an ammeter that is suitable for the investigation. [1 mark]

FIGURE 10



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03.2

Describe

- **a procedure to obtain valid experimental data using your circuit**
- **how these data are processed to obtain ε and r by a graphical method.**

[4 marks]

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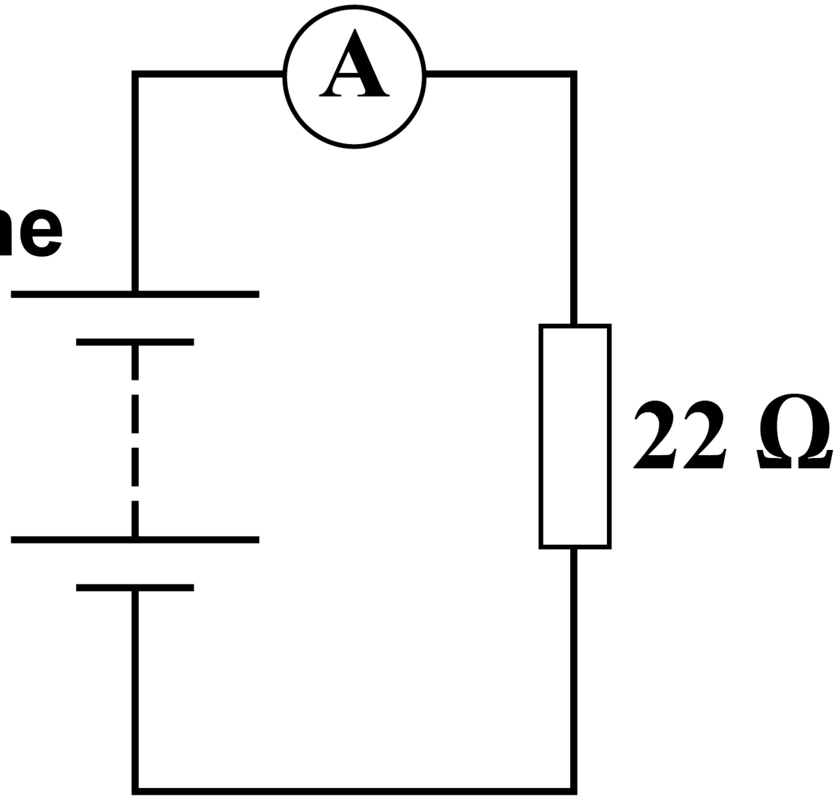
[Turn over]

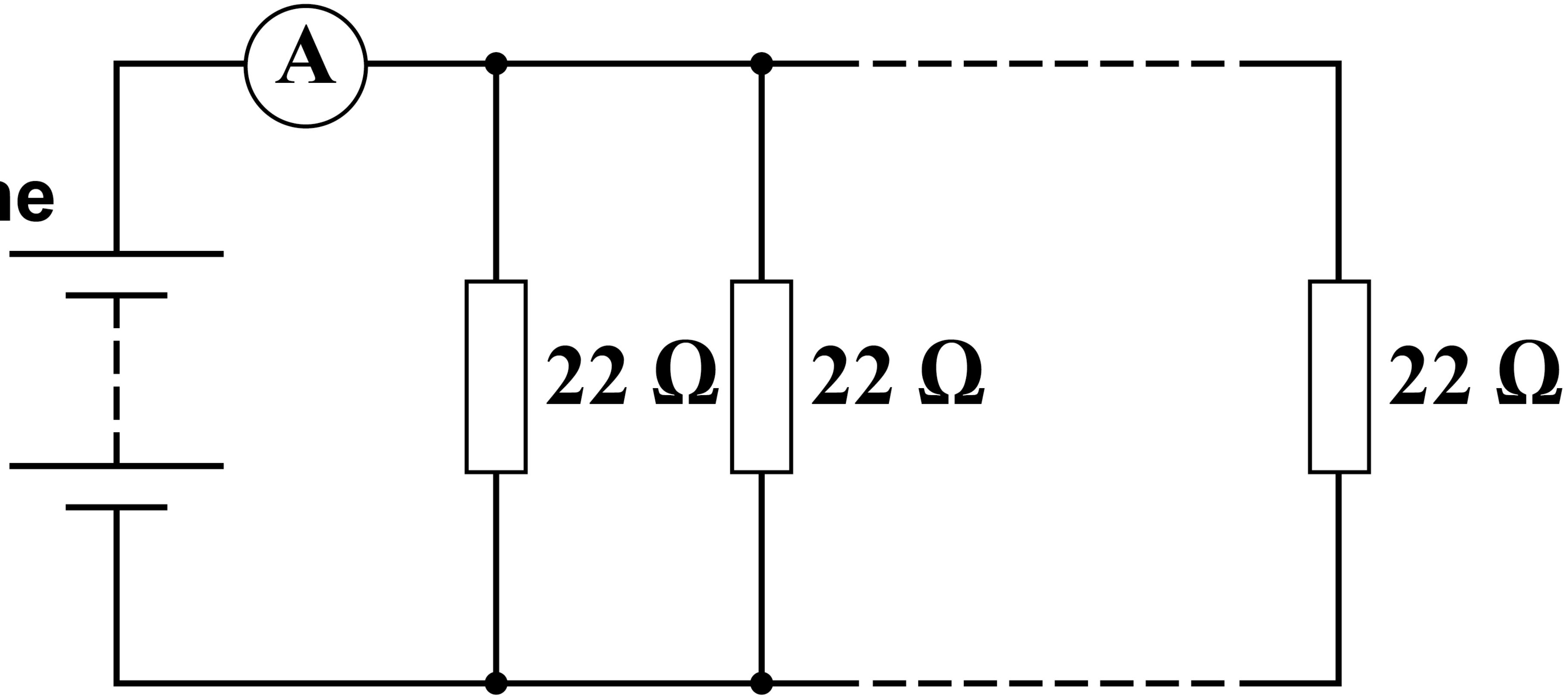
FIGURE 11, on the opposite page, shows a different experiment carried out to confirm the results for $\mathcal{E}$ and r.

FIGURE 11

measuring the current with one 22 Ω resistor connected



measuring the current with further 22 Ω resistors connected



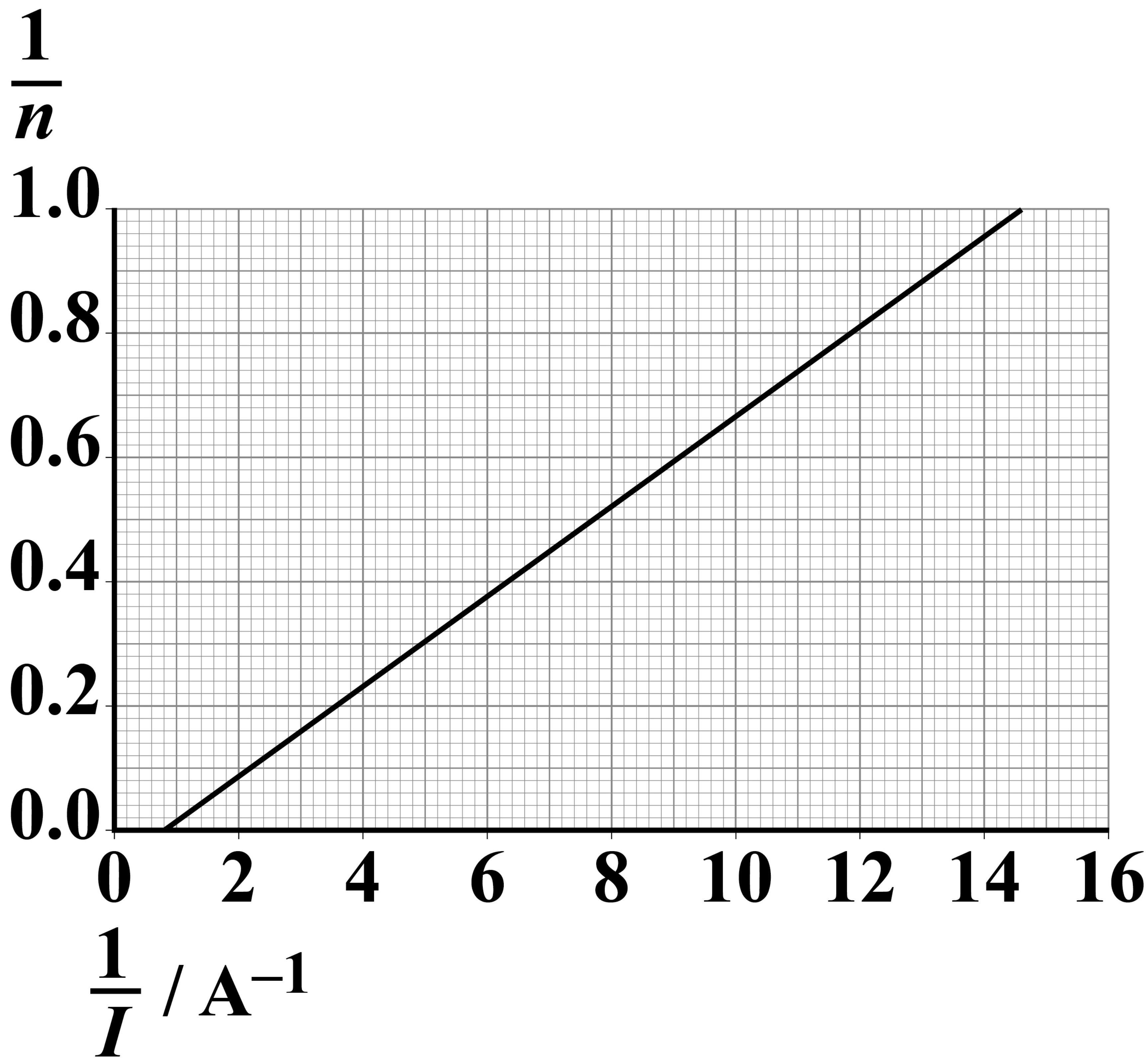
Initially the power supply is connected in series with an ammeter and a $22\ \Omega$ resistor. The current I in the circuit is measured.

The number n of $22\ \Omega$ resistors in the circuit is increased as shown in FIGURE 11. The current I is measured after each resistor is added.

It can be shown that $\dfrac{22}{n} = \dfrac{\varepsilon}{I} - r$

FIGURE 12, on the opposite page, shows a graph of the experimental data.

FIGURE 12



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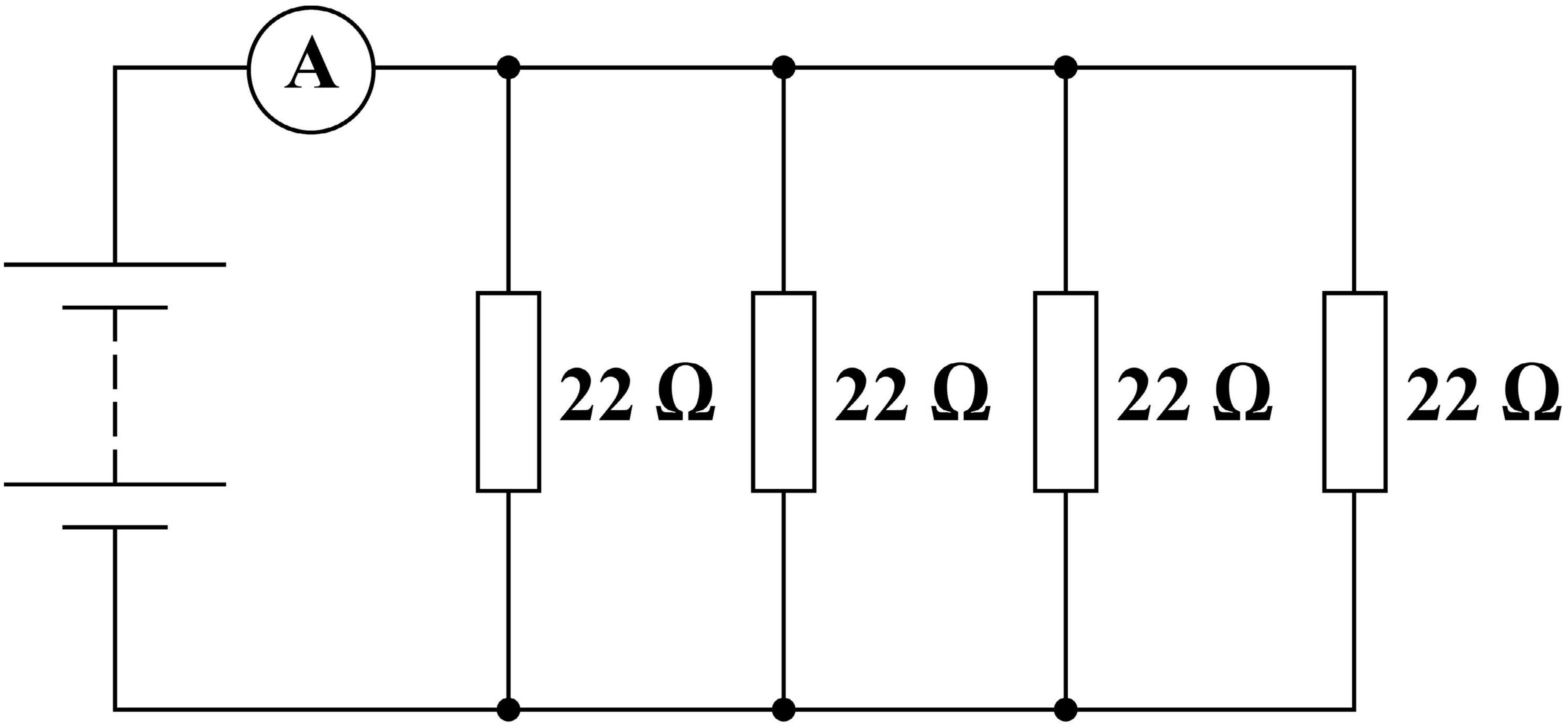
0 3 . 3

Show that $\mathcal{E}$ is about 1.6 V. [2 marks]

0 3 . 4

FIGURE 13 shows the circuit when four resistors are connected.

FIGURE 13



Show, using FIGURE 12, that the current in the power supply is about 0.25 A.
[1 mark]

0 3 . 5

Deduce, for the circuit shown in FIGURE 13,

- **the potential difference (pd) across the power supply**
- ***r*.**

[4 marks]

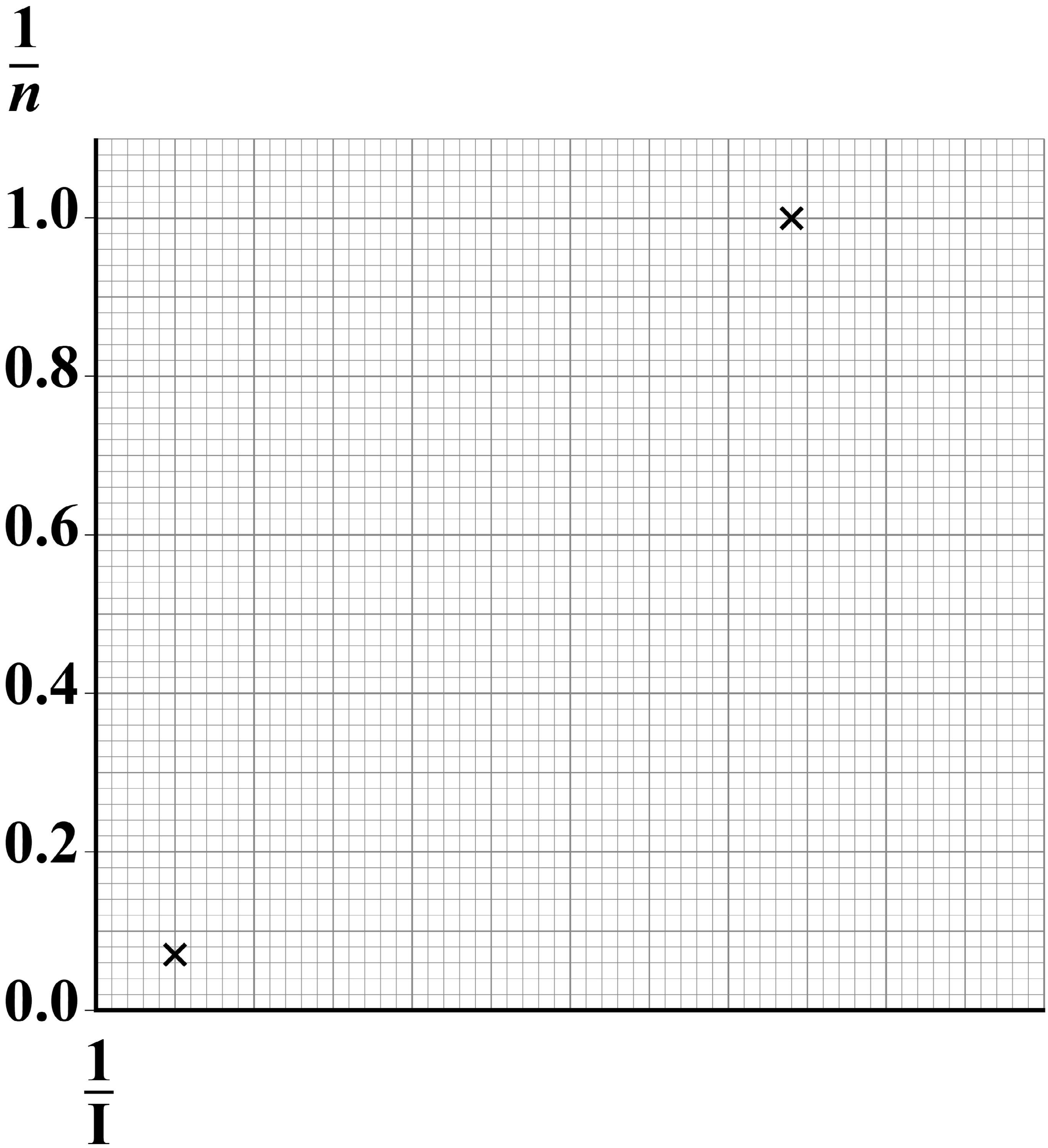
pd = ______________________ **V**

***r* =** ______________________ **Ω**

0 3 . 6

FIGURE 14 shows the plots for $n = 1$ and $n = 14$

FIGURE 14



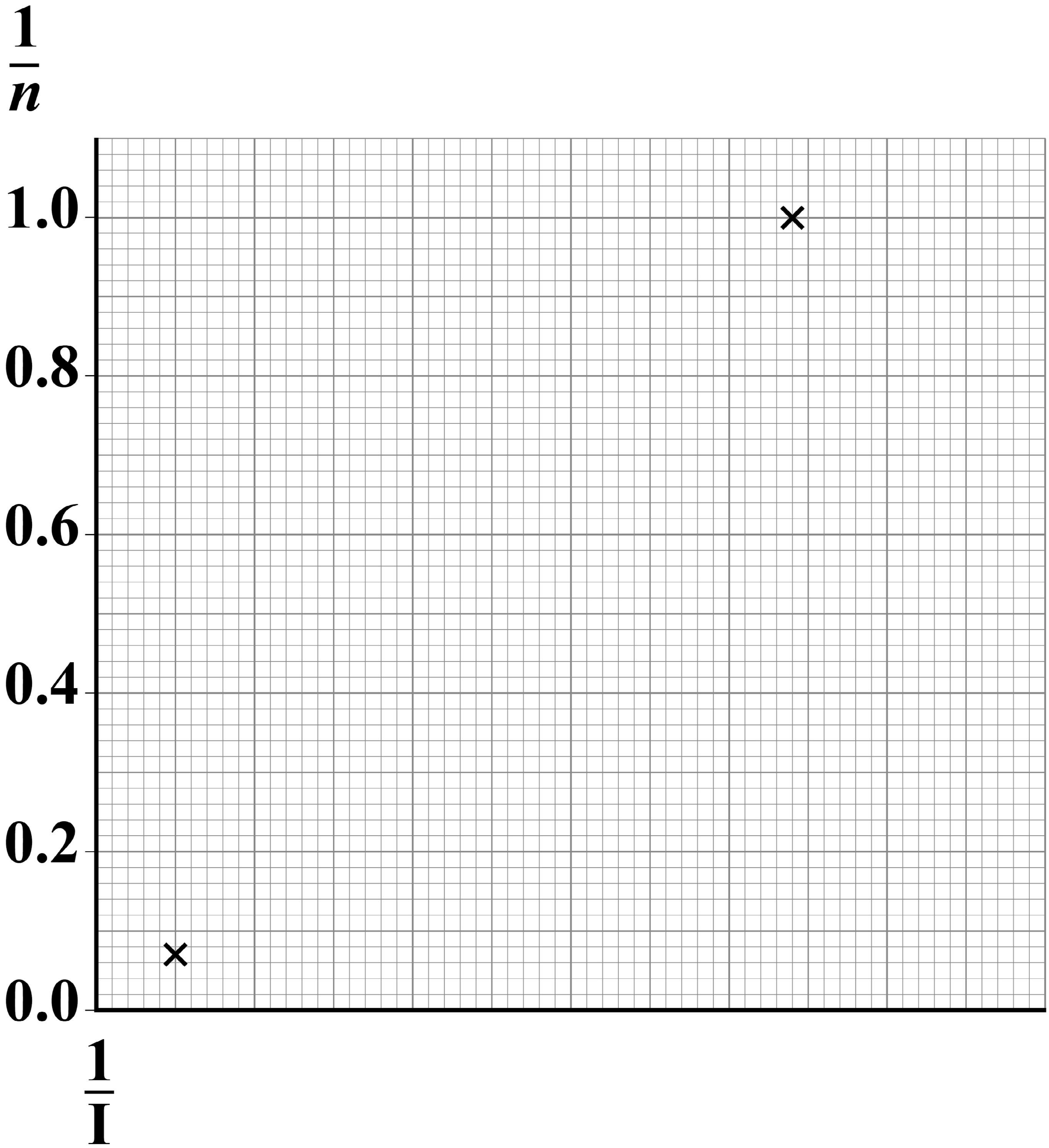
THREE additional data sets for values of n between $n = 1$ and $n = 14$ are needed to complete the graph in FIGURE 14.

Suggest which additional values of n should be used.

Justify your answer. [3 marks]

[Turn over]

REPEAT OF FIGURE 14



0 3 . 7

The experiment is repeated using a set of resistors of resistance 27 Ω.

The relationship between n and I is now

$$\frac{27}{n} = \frac{\varepsilon}{I} - r$$

Show on FIGURE 14 the effect on the plots for $n = 1$ and $n = 14$

You do not need to do a calculation.
[2 marks]

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END OF QUESTIONS

Additional page, if required.
Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
1	
2	
3	
TOTAL	

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