Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3609122403

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2019**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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[Turn over

1 A student is investigating the bending of a loaded wooden strip. Fig. 1.1 shows a rectangular strip of width *b* and thickness *t* overhanging the edge of a bench. A length *L* of the strip is unsupported.

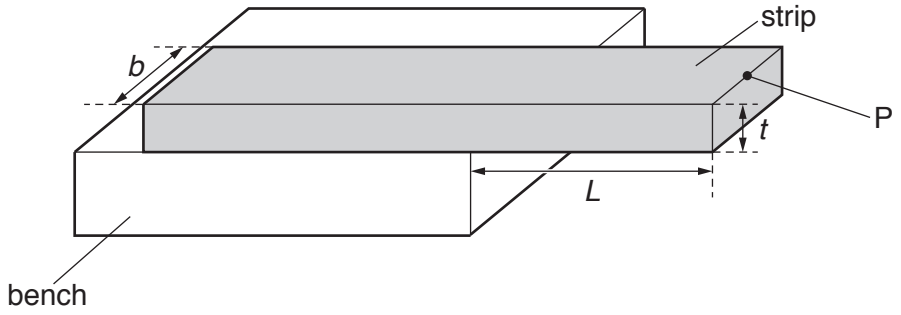

Fig. 1.1

A load of mass *M* is positioned at point P. This causes the unsupported part of the strip to bend with a deflection *s*, as shown in Fig. 1.2.

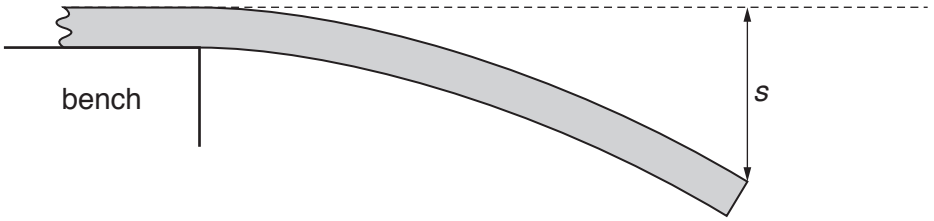

Fig. 1.2 (not to scale)

It is suggested that the relationship between *s* and *L* is

$$E = \frac{4MgL^3}{bst^3}$$

where *g* is the acceleration of free fall and *E* is the Young modulus of the wood.

Design a laboratory experiment to test the relationship between *s* and *L*.
Explain how your results could be used to determine a value for *E*.

You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to:

- the procedure to be followed
- the measurements to be taken
- the control of variables
- the analysis of the data
- any safety precautions to be taken.

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Diagram

[15]

2 A student is investigating a rotary variable resistor, as shown in Fig. 2.1.

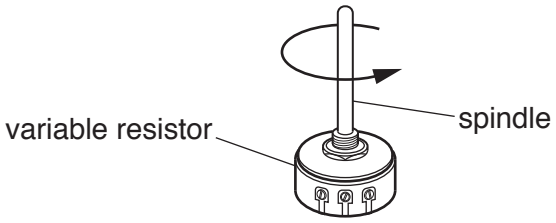

Fig. 2.1

The variable resistor is connected to a battery of electromotive force (e.m.f.) E and negligible internal resistance, as shown in Fig. 2.2.

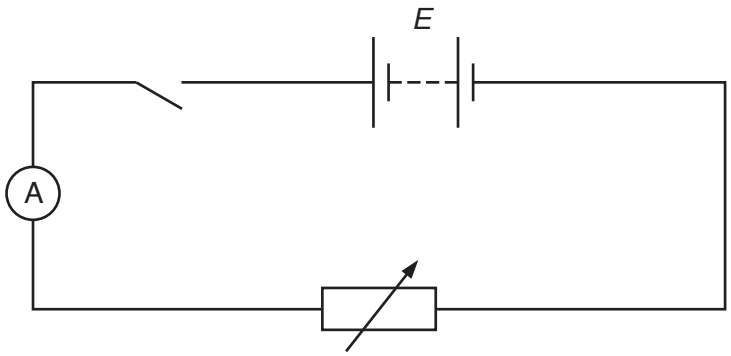

Fig. 2.2

The student uses a protractor to measure the angle θ through which the spindle of the variable resistor is rotated and records the current I.

The experiment is repeated for different angles.

It is suggested that I and θ are related by the equation

$$E = IK\theta$$

where K is a constant.

(a) A graph is plotted of $\frac{1}{I}$ on the y-axis against θ on the x-axis.

Determine an expression for the gradient.

gradient = ... [1]

(b) Values of θ and I are given in Fig. 2.3.

θ/°	I/mA	$\frac{1}{I}$/A^{-1}
95	5.7 ± 0.1	
115	4.7 ± 0.1	
135	4.0 ± 0.1	
155	3.5 ± 0.1	
175	3.1 ± 0.1	
195	2.7 ± 0.1	

Fig. 2.3

Calculate and record values of $\frac{1}{I}$/A^{-1} in Fig. 2.3.

Include the absolute uncertainties in $\frac{1}{I}$. [2]

(c) (i) Plot a graph of $\frac{1}{I}$/A^{-1} against θ/°.

Include error bars for $\frac{1}{I}$/A^{-1}. [2]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labelled. [2]

(iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

gradient = ... [2]

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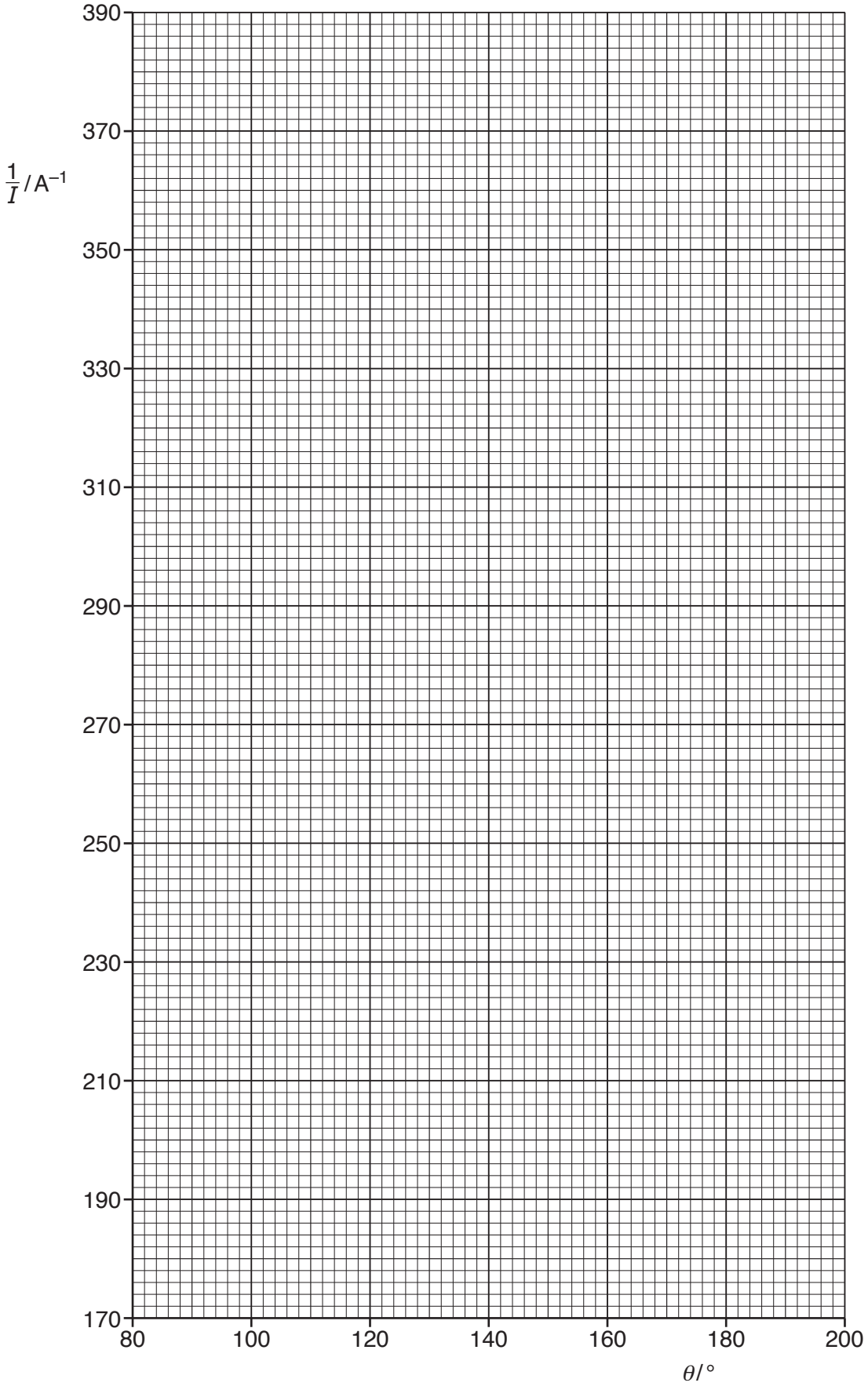
390
370
$\frac{1}{I}$ / A^{-1}
350
330
310
290
270
250
230
210
190
170
80
100
120
140
160
180
200
θ / °

(d) The student measured the e.m.f. of the battery twice. The student's values were 9.6 V and 9.2 V.
Determine the average e.m.f. E of the battery. Include the absolute uncertainty in E.

E = ... V [1]

(e) **(i)** Using your answers to **(a)**, **(c)(iii)** and **(d)**, determine the value of K. Include an appropriate unit.

K = ... [2]

(ii) Determine the percentage uncertainty in K.

percentage uncertainty = ...% [1]

(f) Determine the angle θ through which the spindle of the variable resistor is rotated so that the current is 10.0 mA. Include the absolute uncertainty in your answer.

θ = ...° [2]

[Total: 15]

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