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9702/51

May/June 2013

1 hour 15 minutes

No Additional Materials are required.

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 a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, 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.

This document consists of **8** printed pages.

- 1 A student is investigating the flow of water through a horizontal tube.

The rate Q (volume per unit time) at which water flows through a tube depends on the pressure difference per unit length across the tube.

The student has the use of a metal can with two holes. A narrow horizontal tube goes through the hole in the side of the can. The can is continuously supplied with water from a tap. The level of water in the can is kept constant by the position of a wide vertical tube which passes through the hole in the bottom of the can as shown in Fig. 1.1. Both tubes may be moved along the holes.

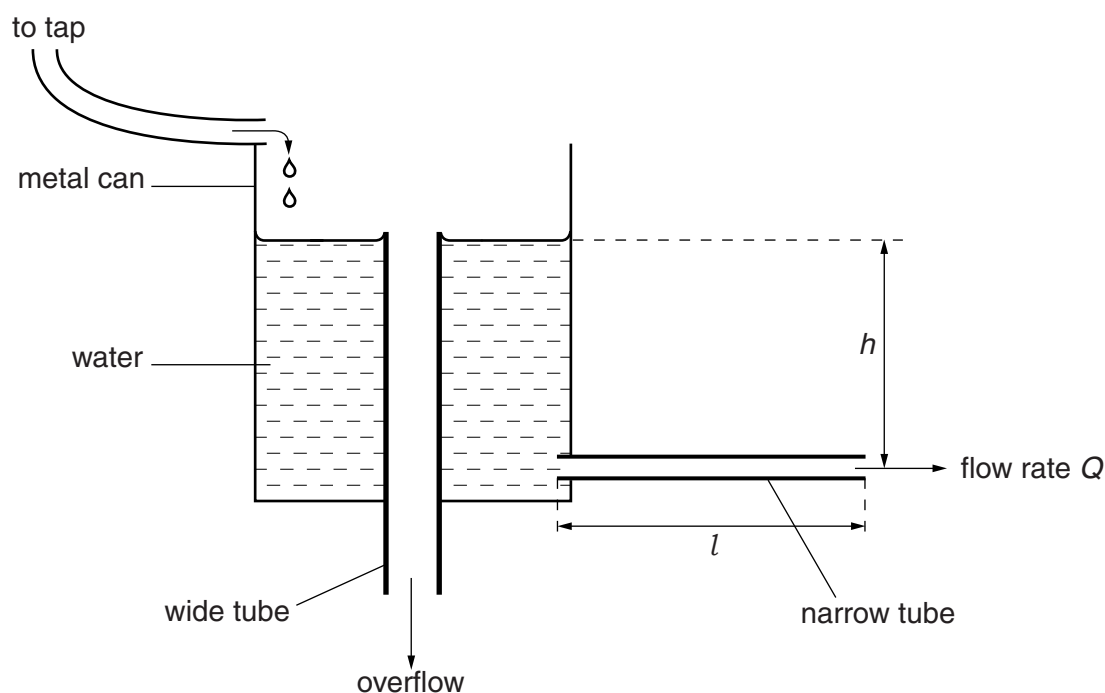


Fig. 1.1

It is suggested that the relationship between the flow rate Q of water through the narrow horizontal tube and the vertical height h is

$$Q = \frac{2\pi\rho gh d^4}{l\eta}$$

where ρ is the density of water, g is the acceleration of free fall, d is the internal diameter of the tube, l is the length of the tube and η is a constant.

Design a laboratory experiment to test the relationship between Q and h and determine a value for η . 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,
- the safety precautions to be taken.

For
Examiner's
Use

[15]

Diagram

*For
Examiner's
Use*

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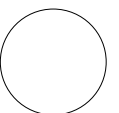
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For Examiner's Use	Defining the problem	Methods of data collection	Method of analysis	Safety considerations	Additional detail



2 A student is investigating the discharge of capacitors.

A capacitor of capacitance W is charged by connecting it to a power supply of e.m.f. E . The charge is then shared with another capacitor of capacitance C , which is initially uncharged. A voltmeter is used to measure the maximum voltage V across the second capacitor, as shown in Fig. 2.1.

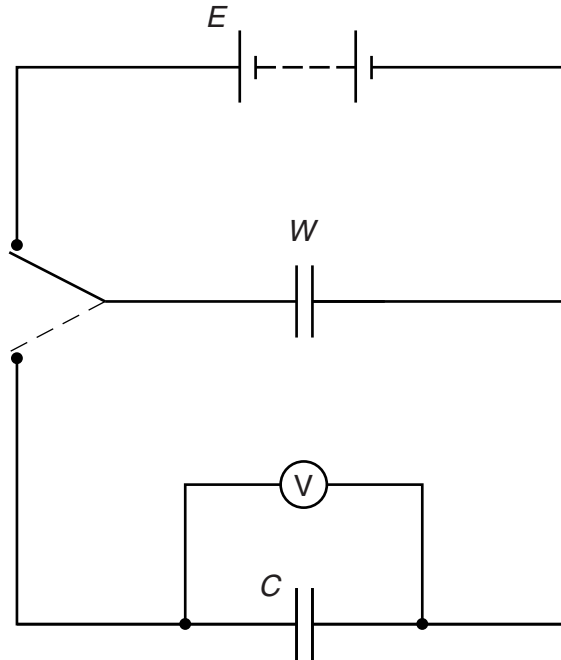


Fig. 2.1

For different values of C , the maximum voltage V is recorded.

Question 2 continues on the next page.

It is suggested that C and V are related by the equation

$$\frac{E}{V} = 1 + \frac{C}{W}.$$

For
Examiner's
Use

- (a) A graph is plotted of $1/V$ on the y -axis against C on the x -axis. Determine expressions for the gradient and y -intercept in terms of E and W .

gradient = ...

y -intercept = ...

[1]

- (b) Values of C and V are given in Fig. 2.2.

$C/10^{-3}\text{F}$	V/V	
0.69 ± 0.09	5.1	
1.00 ± 0.20	4.5	
1.47 ± 0.29	4.0	
2.20 ± 0.44	3.3	
2.67 ± 0.54	3.0	
3.20 ± 0.64	2.7	

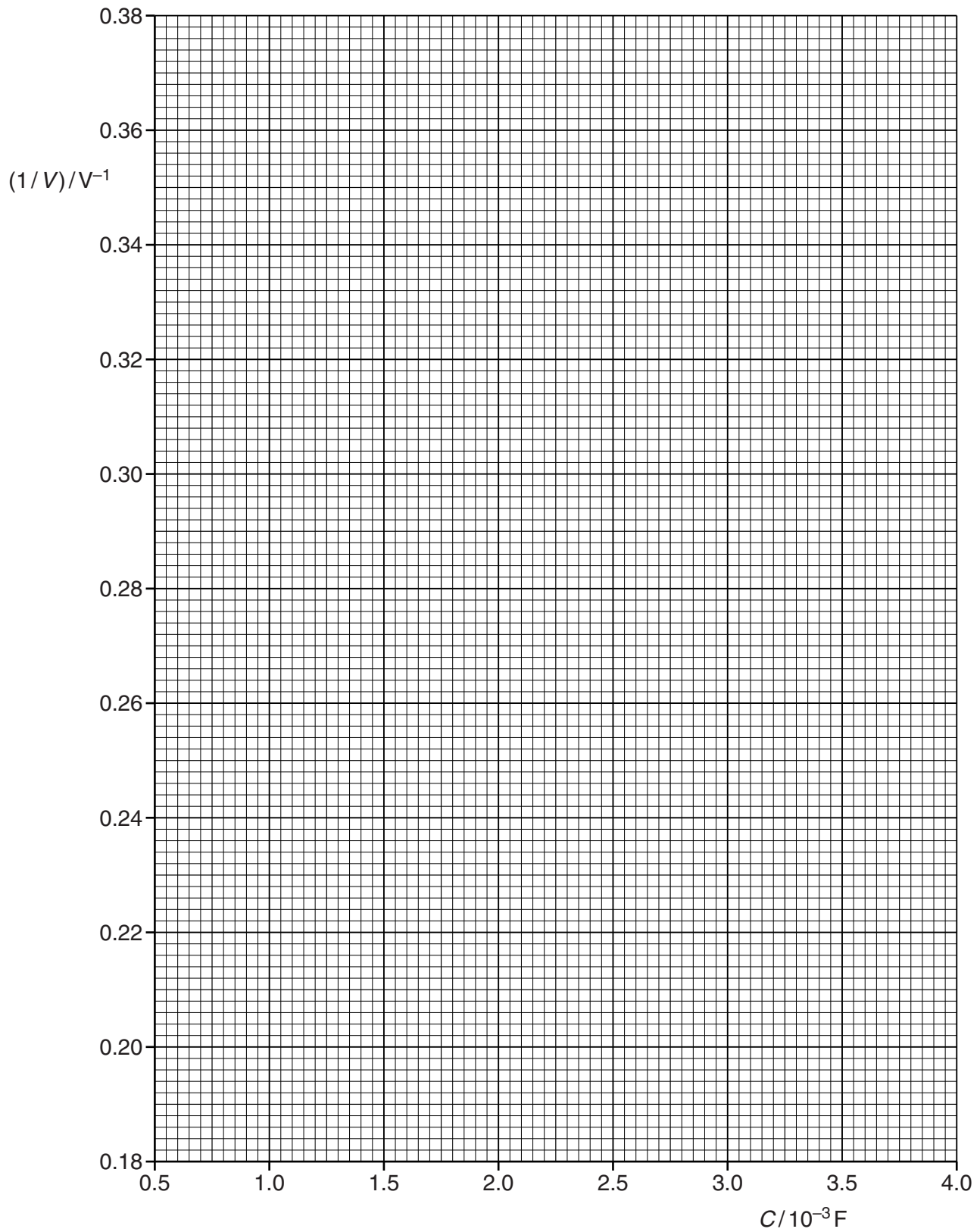
Fig. 2.2

Calculate and record values of $1/V$ in Fig. 2.2.

[2]

- (c) (i) Plot a graph of $(1/V)/V^{-1}$ against $C/10^{-3}\text{F}$. Include error bars for C . [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 uncertainty in your answer.

gradient = ... [2]



- (iv) Determine the y -intercept of the line of best fit. Include the uncertainty in your answer.

For
Examiner's
Use

y -intercept = ...[2]

- (d) (i) Using your answer to (c)(iv), determine a value for E . Include an appropriate unit in your answer. Include the absolute uncertainty in E .

E = ...[2]

- (ii) Using your answers to (c)(iii) and (d)(i), determine a value for W . Include an appropriate unit in your answer.

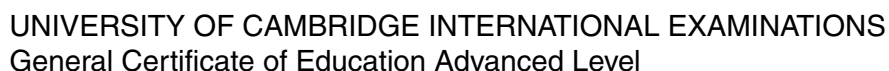
W = ...[1]

- (iii) Determine the percentage uncertainty in your value of W .

percentage uncertainty = ... % [1]

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9702/52

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READ THESE INSTRUCTIONS FIRST

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This document consists of **8** printed pages.

- 1 A student is investigating how the peak alternating current I_0 varies with frequency f in a circuit containing a coil of wire.

For
Examiner's
Use

It is suggested that

$$\left(\frac{V_0}{I_0}\right)^2 = R^2 + 4\pi^2 f^2 L^2$$

where R is the resistance of the coil, V_0 is the peak voltage and L is a constant.

Design a laboratory experiment to test the relationship between I_0 and f and determine a value for L . You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to

- (a) the procedure to be followed,
- (b) the measurements to be taken,
- (c) the control of variables,
- (d) the analysis of the data,
- (e) the safety precautions to be taken.

[15]

Diagram

*For
Examiner's
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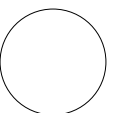
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[illegible]

For Examiner's Use	Defining the problem	Methods of data collection	Method of analysis	Safety considerations	Additional detail



- 2 An electron beam is accelerated by a voltage V before entering a uniform electric field of electric field strength E between two parallel plates.

For
Examiner's
Use

The electron beam travels a horizontal distance a parallel to the plates before hitting the top plate after being deflected through a vertical distance b . The path of the electrons is shown in Fig. 2.1.

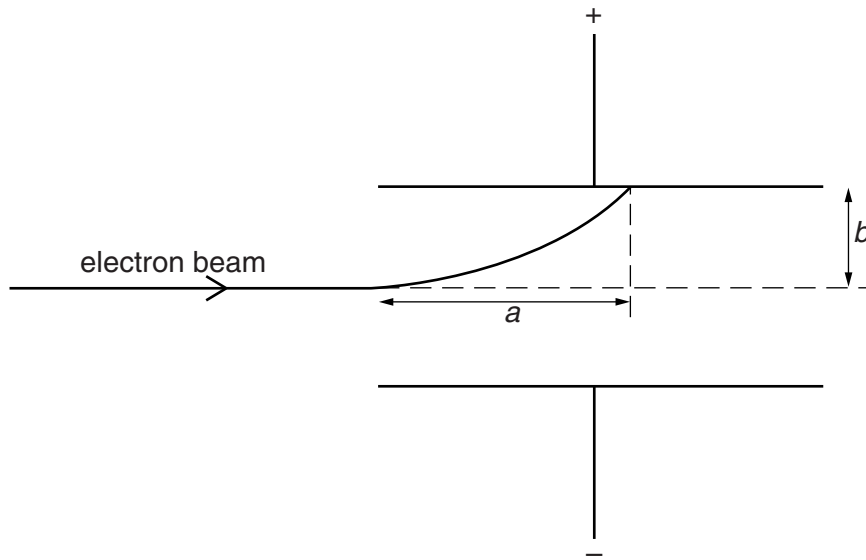


Fig. 2.1

For different values of V , the horizontal distance a is recorded.

Question 2 continues on the next page.

It is suggested that V and a are related by the equation

$$a = \sqrt{\frac{4Vb}{E}}.$$

For
Examiner's
Use

- (a) A graph is plotted of a^2 on the y -axis against V on the x -axis. Determine an expression for the gradient in terms of E .

gradient = ... [1]

- (b) Values of V and a are given in Fig. 2.2.

V/V	$a/10^{-2}\text{m}$	
1000	6.6 ± 0.1	
1200	7.2 ± 0.1	
1400	7.8 ± 0.1	
1600	8.4 ± 0.1	
1800	8.9 ± 0.1	
2000	9.4 ± 0.1	

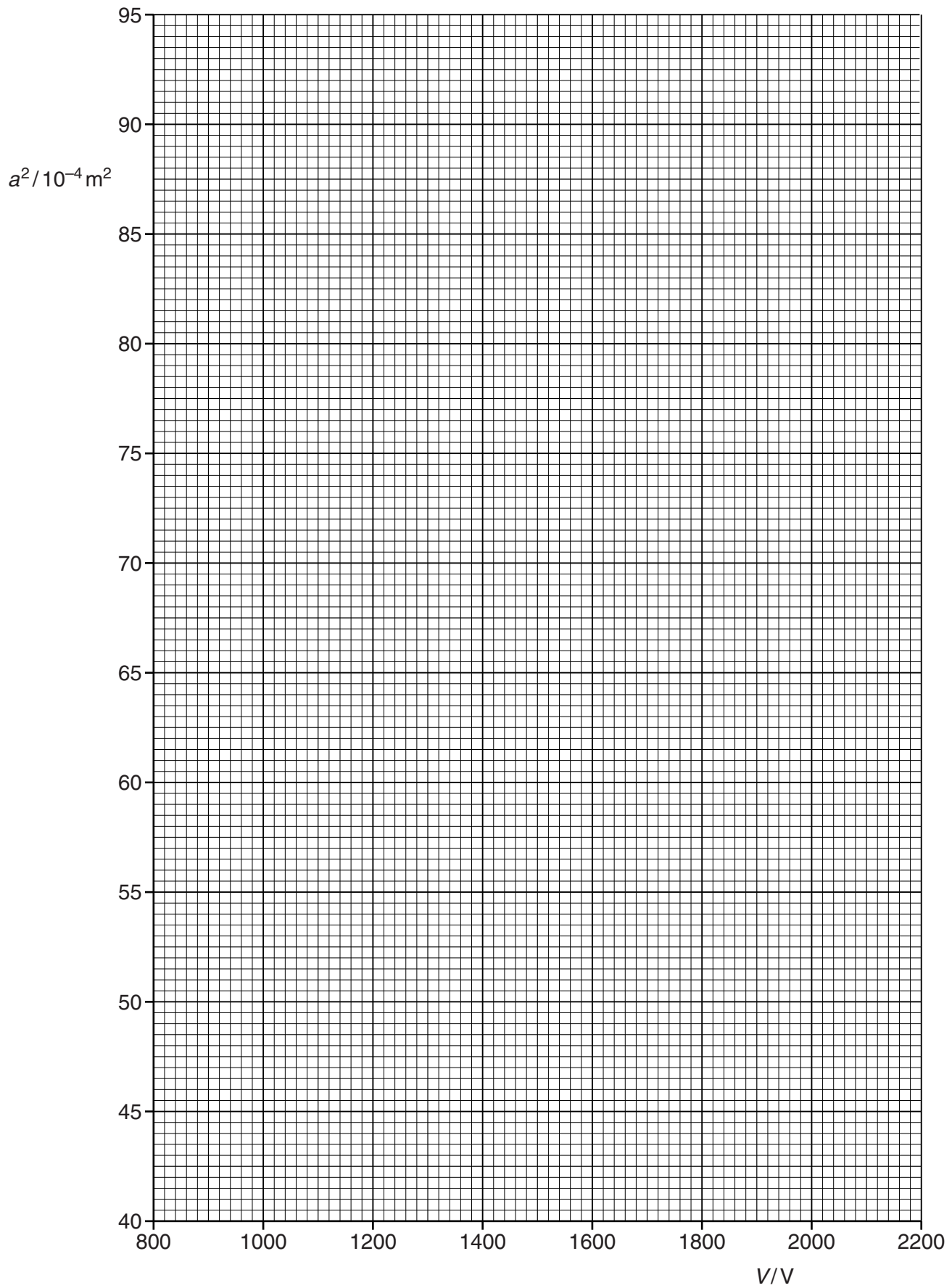
Fig. 2.2

Calculate and record values of $a^2/10^{-4}\text{m}^2$ in Fig. 2.2. Include the absolute uncertainties in a^2 . [3]

- (c) (i) Plot a graph of $a^2/10^{-4}\text{m}^2$ against V/V . Include error bars for a^2 . [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 uncertainty in your answer.

gradient = ... [2]

For
Examiner's
Use



- (d) (i) Using your answer to (c)(iii), determine a value for E . Include an appropriate unit in your answer.

Data: $b = (4.0 \pm 0.1) \times 10^{-2} \text{ m}$

For
Examiner's
Use

$E = \dots\dots\dots$ [2]

- (ii) Determine the percentage uncertainty in your value of E .

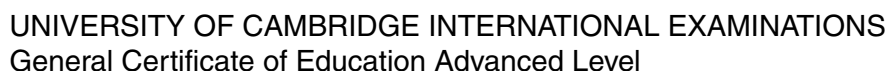
percentage uncertainty = $\dots\dots\dots\%$ [1]

- (e) Using your answers to (d), determine a value for V to give a distance $a = 5.0 \pm 0.1 \text{ cm}$. Include the absolute uncertainty in your answer.

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

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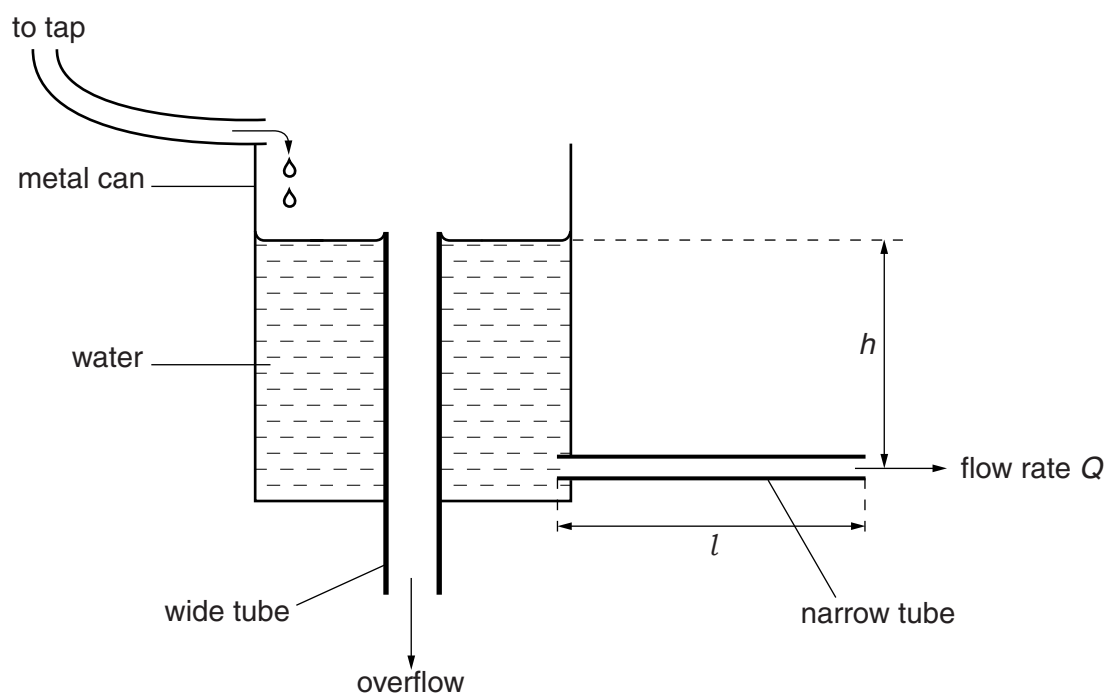


Fig. 1.1

It is suggested that the relationship between the flow rate Q of water through the narrow horizontal tube and the vertical height h is

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For
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[15]

Diagram

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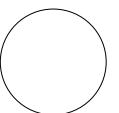
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For Examiner's Use	Defining the problem	Methods of data collection	Method of analysis	Safety considerations	Additional detail



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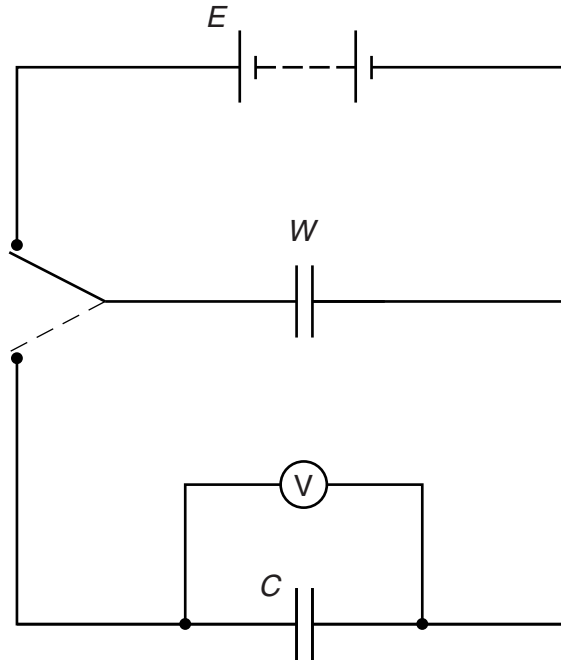


Fig. 2.1

For different values of C , the maximum voltage V is recorded.

Question 2 continues on the next page.

It is suggested that C and V are related by the equation

$$\frac{E}{V} = 1 + \frac{C}{W}.$$

For
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- (a) A graph is plotted of $1/V$ on the y -axis against C on the x -axis. Determine expressions for the gradient and y -intercept in terms of E and W .

gradient = ...

y -intercept = ...

[1]

- (b) Values of C and V are given in Fig. 2.2.

$C/10^{-3}\text{F}$	V/V	
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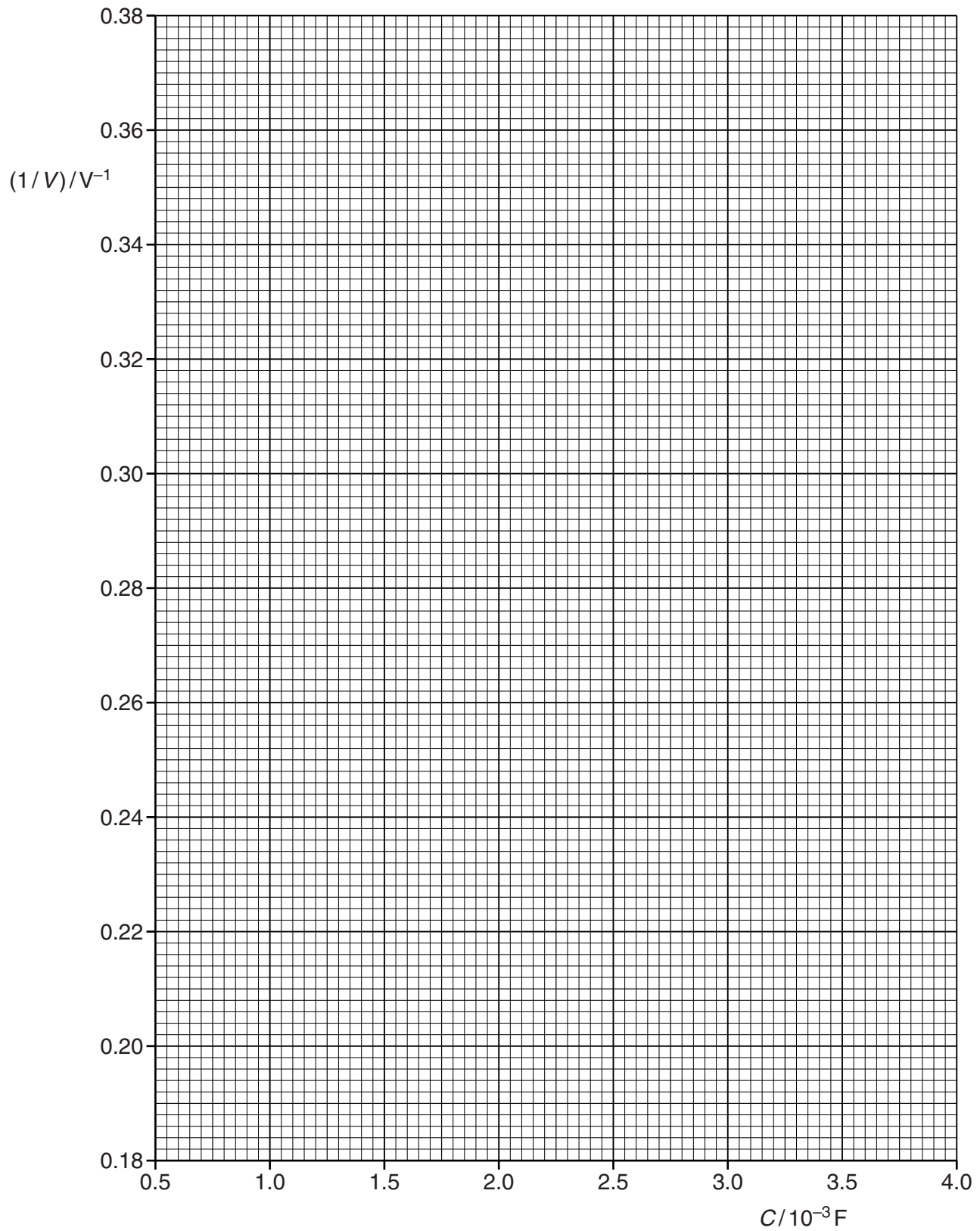
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Calculate and record values of $1/V$ in Fig. 2.2.

[2]

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gradient = ... [2]



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For
Examiner's
Use

y -intercept = ... [2]

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E = ... [2]

- (ii) Using your answers to (c)(iii) and (d)(i), determine a value for W . Include an appropriate unit in your answer.

W = ... [1]

- (iii) Determine the percentage uncertainty in your value of W .

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