Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

1301813285

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2018**

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.

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

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1 A student is investigating how the boiling point of a salt solution varies with pressure.

It is suggested that the relationship between the Celsius temperature θ at which the water of the solution starts to boil and the air pressure P is

$$\theta = k\sigma P^q$$

where σ is the density of the solution and k and q are constants.

Design a laboratory experiment to test the relationship between θ and P.
Explain how your results could be used to determine values for k and q.

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

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2 A student is investigating the electric potential near a charged metal sphere. The sphere is suspended from the ceiling as shown in Fig. 2.1.

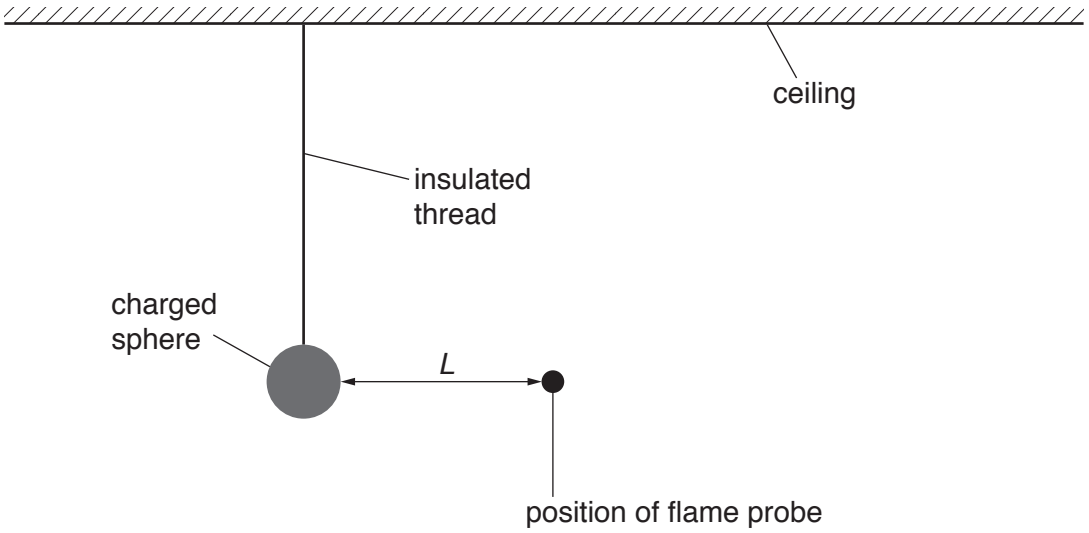

Fig. 2.1

A flame probe is used to measure the potential V at a distance L from the surface of the sphere. The experiment is repeated for different distances from the sphere.

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

$$V = \frac{Q}{4\pi\varepsilon_0(L + a)}$$

where Q is the charge on the sphere, a is the radius of the sphere and ε_0 is the permittivity of free space.

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

Determine expressions for the gradient and the y-intercept.

gradient = ...

y-intercept = ...

[1]

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

L/m	V/kV	$\frac{1}{V}/10^{-3}\,V^{-1}$
0.018	1.25 ± 0.05	
0.036	1.05 ± 0.05	
0.053	0.90 ± 0.03	
0.068	0.80 ± 0.03	
0.089	0.70 ± 0.02	
0.113	0.60 ± 0.02	

Fig. 2.2

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

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

(c) **(i)** Plot a graph of $\frac{1}{V}/10^{-3}\,V^{-1}$ against L/m.

Include error bars for $\frac{1}{V}$. [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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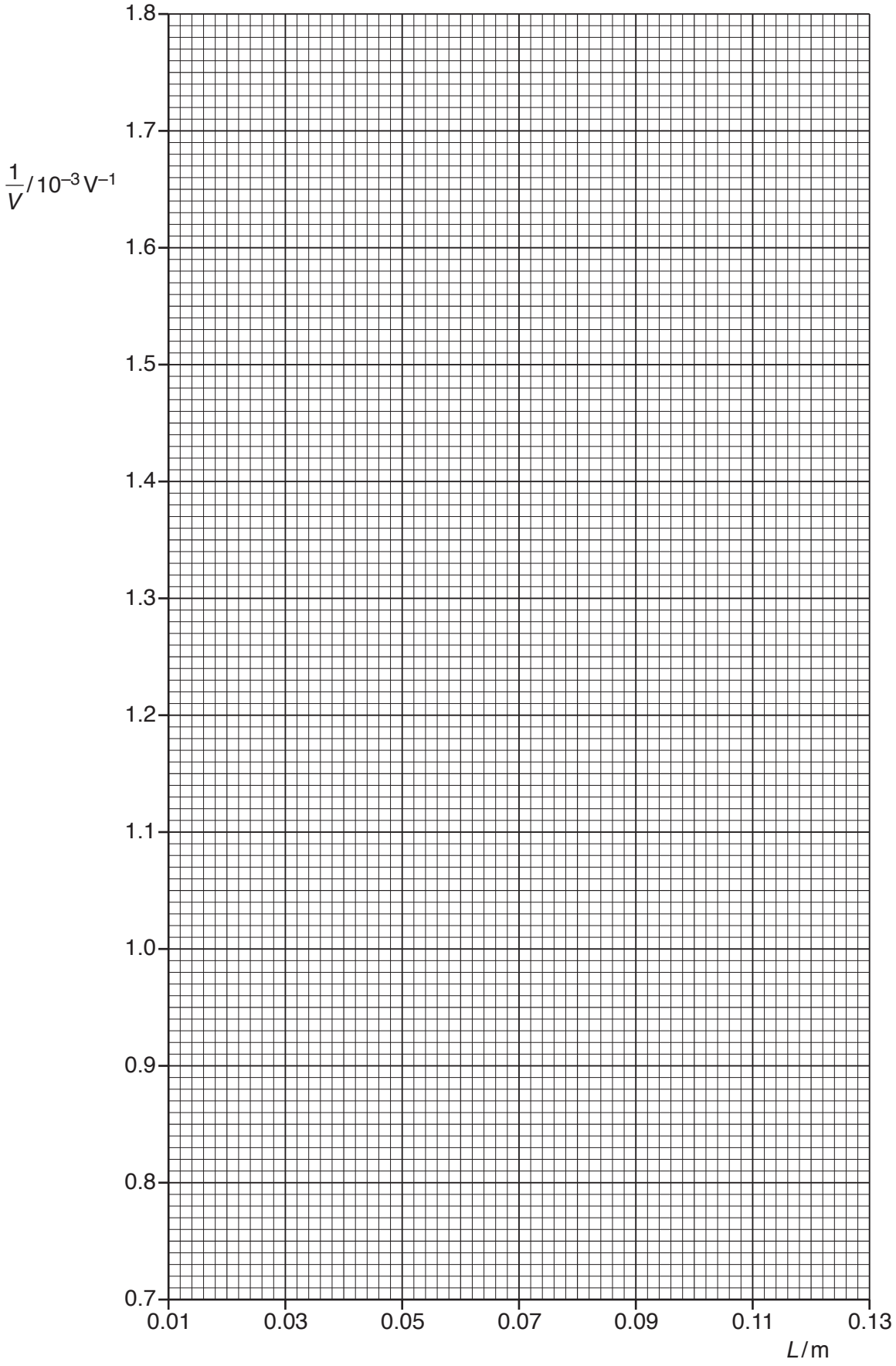
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
1/V / 10^−3 V^−1
0.01
0.03
0.05
0.07
0.09
0.11
0.13
L / m

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

y-intercept = ... [2]

(d) (i) Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine the values of *a* and *Q*. Include an appropriate unit for *Q*.

Data: $\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$.

a = ... m

Q = ...
[3]

(ii) Determine the percentage uncertainty in *a*.

percentage uncertainty in *a* = ... % [1]

[Total: 15]

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