OCR
Oxford Cambridge and RSA

A Level Physics B (Advancing Physics)

H557/03 Practical skills in physics

Practice paper – Set 2

Time allowed: 1 hour 30 minutes

2016

You must have:
- the Data, Formula and Relationships booklet

You may use:
- a scientific or graphical calculator
- a ruler (cm/mm)

First name										
Last name										
Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **20** pages.

SECTION A

Answer **all** the questions.

1 This question is about the determination of the specific thermal capacity of aluminium.

An electrical heater is used to raise the temperature of a 1.0 kg aluminium block in the circuit shown in Fig. 1.1.

The switch is closed, switching the heater on for **ten** minutes before the switch is opened, which turns the heater off.

The temperature of the block is recorded at one minute intervals for **fifteen** minutes.

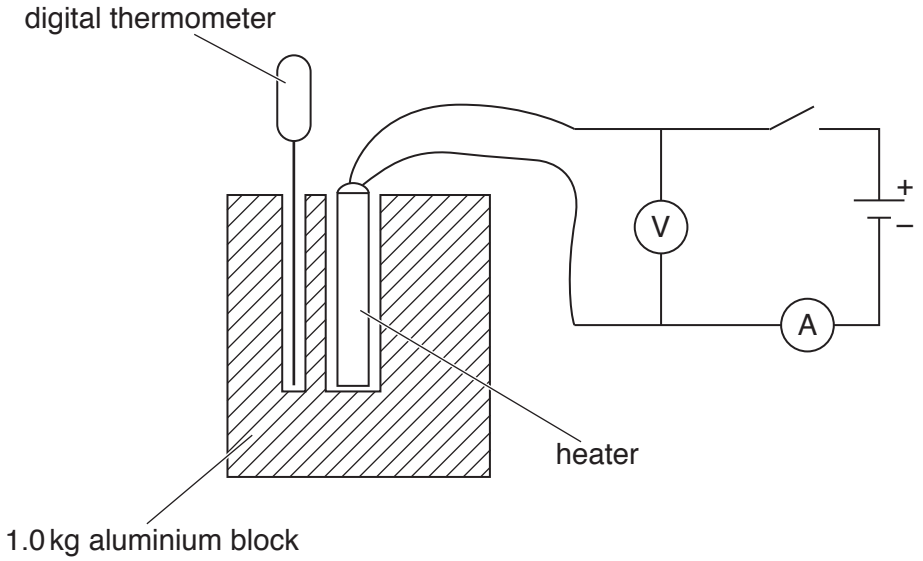

Fig 1.1

Readings are taken of potential difference across the heater and current through the heater every two minutes. The results are shown in the table.

Time t / minutes	Potential difference V / V	Current I /A	Power P / W
0		2.30	19.8
2	8.67	2.35	20.4
4	8.74		20.3
6	8.75	2.42	21.0
8	8.69	2.39	20.8
10	8.70	2.41	

(a) (i) Complete the missing values in the table. **[3]**

(ii) Calculate the mean power. Include the uncertainty in the value.

mean power = ... ± ..... W **[2]**

Fig. 1.2 shows a graph of temperature against time.

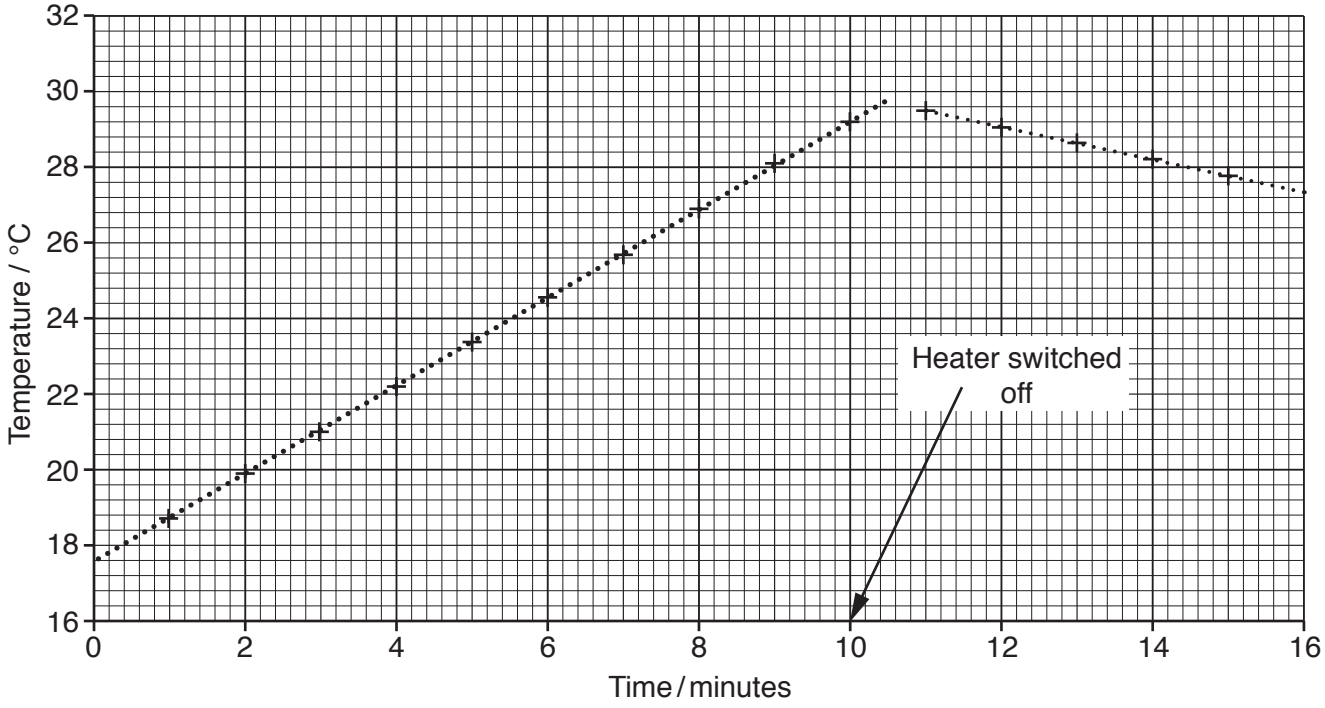

Fig 1.2

(b) (i) Use data from the first ten minutes of the graph and your answer to **(a)(ii)** to show that the specific thermal capacity of aluminium is about $1000\,J\,kg^{-1}\,K^{-1}$.

[3]

(ii) Use Fig. 1.2 to estimate the maximum rate of cooling when the switch is opened.

maximum rate of cooling = ... $K\ min^{-1}$ **[2]**

(c) The total percentage uncertainty in the investigation is found to be 5 %. The accepted value of the specific thermal capacity of aluminium is 897 $J\,kg^{-1}\,K^{-1}$.

Calculate the percentage difference between your calculated value from **(b)(i)** and the accepted value and use this to comment on the accuracy of the investigation. Suggest reasons for the difference between the investigation value and the accepted value.

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2 This question is about investigating the terminal velocity of paper cupcake cases.

A paper cupcake case is dropped from a height of 2.0 m and the time taken *t* to fall to the ground is recorded using a stopwatch.

Fig. 2.1 shows a dot-plot recording the values obtained for *t*.

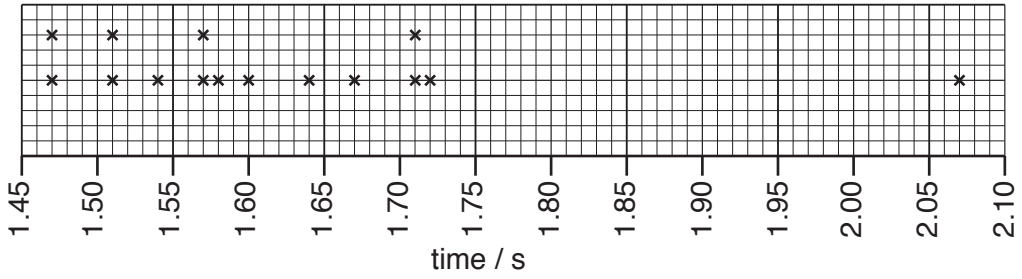

Fig. 2.1

(a) Suggest a practical reason for the outlying result of 2.07 s.

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(b) Fig. 2.2 shows a sketch graph of velocity against time for the cupcake case.

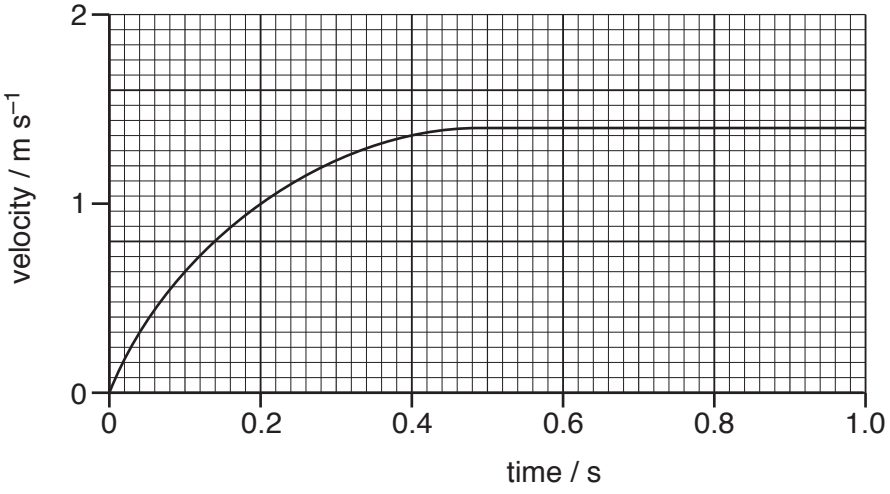

Fig. 2.2

(i) Explain the shape of the graph. Refer to the forces acting on the cupcake case in your answer.

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(ii) The mass of the cupcake case is changed by inserting a second case inside the first. Draw a second graph on Fig. 2.2 showing how the velocity of the cupcake cases changes with time. **[2]**

(iii)* A student wishes to investigate how the mass of the cupcake case affects the size of the terminal velocity reached. Describe practical **methods** to find the terminal velocity reached by the cupcake case using standard school laboratory equipment. Include the measurements taken and the calculations required to determine the terminal velocity as well as ways to reduce any sources of uncertainty.

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3 This question is about an experiment to determine the Planck constant using LEDs.

Fig. 3.1 shows the circuit which is used in a school laboratory.

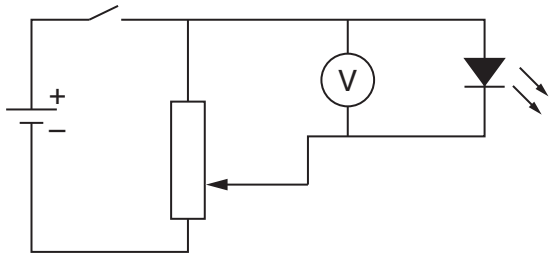

Fig. 3.1

The voltage across each LED is increased until the light emitted from the LED is just visible. This voltage V_t recorded. V_t is found for seven LEDs emitting light of different wavelengths.

(a) V_t for a red LED is measured as 1.35 V. Calculate the energy change of an electron passing through the LED.

energy change = ... J **[1]**

(b) Fig. 3.2 shows a graph of V_t against $1/\lambda$ with uncertainty bars. The line of best fit has been drawn through the points. The gradient of the line is 2.0×10^{-6}.

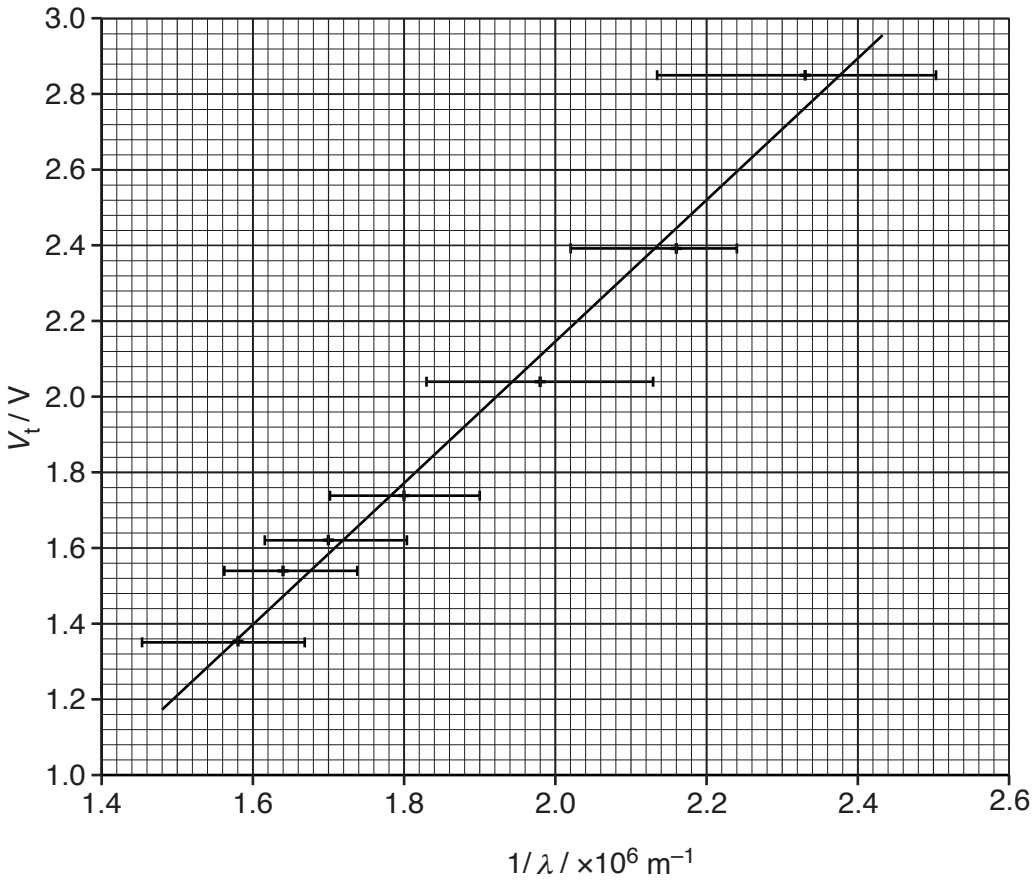

Fig. 3.2

(i) Using the energy-frequency relationship for photons show that the gradient of the line represents

$$\frac{hc}{q}$$

where h is the Planck constant, c is the speed of light in a vacuum and q is the charge on the electron.

[2]

(ii) Hence show that h is found to be about 1.1×10^{-33} J s.

[1]

(iii) A *worst-fit* straight line is one which represents the steepest or least steep possible straight line to pass through all the uncertainty bars. Draw a worst-fit straight line on the graph and calculate a second value for the Planck constant.

[3]

(iv)* Compare the calculated values for h with the accepted value (6.6×10^{-34} J s) and comment on the accuracy of the experiment. Describe the sources of uncertainty in the experiment and suggest improvements.

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[6]

SECTION B

Answer **all** the questions.

4 This question is about the attenuation of gamma radiation as it passes through lead.

Fig. 4.1 shows the experimental set up using a Geiger-Müller tube to detect gamma radiation emitted from a sample of cobalt-60. Different thicknesses of lead sheet are placed between the source and the Geiger-Müller tube and a counter is used to measure the number of counts per minute (cpm).

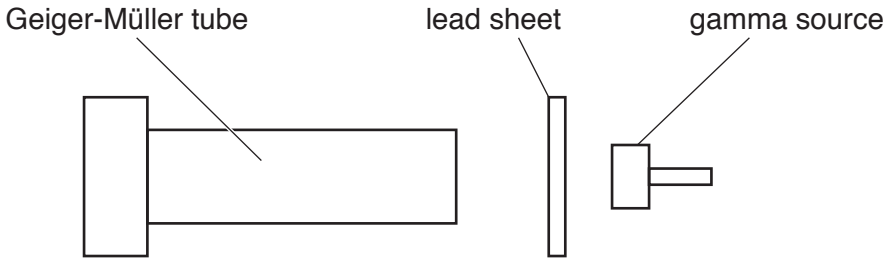

Fig. 4.1

(a) Describe the safety precautions necessary for handling the gamma source.

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(b) The values in the table below have been corrected for background radiation.

thickness of lead x / cm	Intensity I / cpm
0.5	890
1.0	651
1.5	442
2.0	310
2.5	222
3.0	154
3.5	112

(i) Explain why it is important to correct for background radiation.

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Fig. 4.2 shows a plot of I against x.

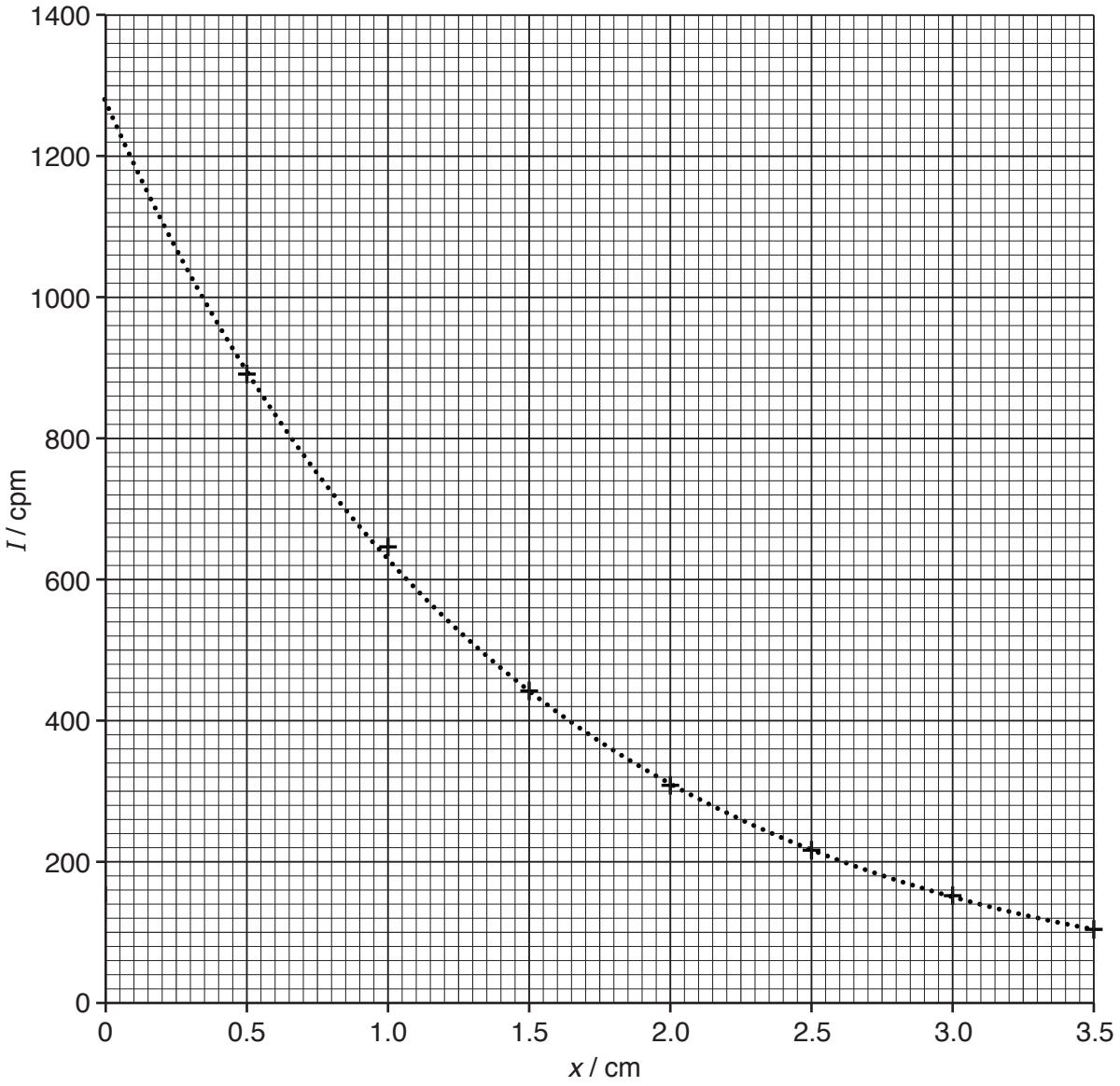

Fig. 4.2

(ii) The *half-thickness* is the thickness of a shielding material required to halve the intensity received by the Geiger-Müller tube. Use the graph to calculate a reliable value for the half-thickness of lead.

half-thickness = ... cm **[3]**

(c) The attenuation of gamma radiation in lead can be described by the equation:

$$I = I_0 e^{-\mu x}$$

where: I is the intensity of radiation reaching the Geiger-Müller tube
I_0 is the intensity of radiation with no lead sheet
x is the thickness of lead in cm
μ is the attenuation coefficient in cm^{-1}.

(i) Show that this equation can be written as

$$\ln (I) = -\mu x + \ln (I_0).$$

[1]

The table shows the data with the values of ln (I / cpm) calculated.

thickness of lead x / cm	**Intensity I / cpm**	**ln (I / cpm)**
0.5	890	6.79
1.0	651	6.48
1.5	442	6.09
2.0	310	5.74
2.5	222	5.40
3.0	154	5.04
3.5	112	4.72

(ii) Plot a graph on the grid provided in Fig. 4.3 of ln (I / cpm) against x. Three points have already been plotted. Draw a line of best fit through the points. **[2]**

(iii) Calculate the gradient and intercept of the line of best fit and use your answer to **(c)(i)** to determine I_0 and μ.

I_0 = ... cpm

μ = ... cm^{-1}

[4]

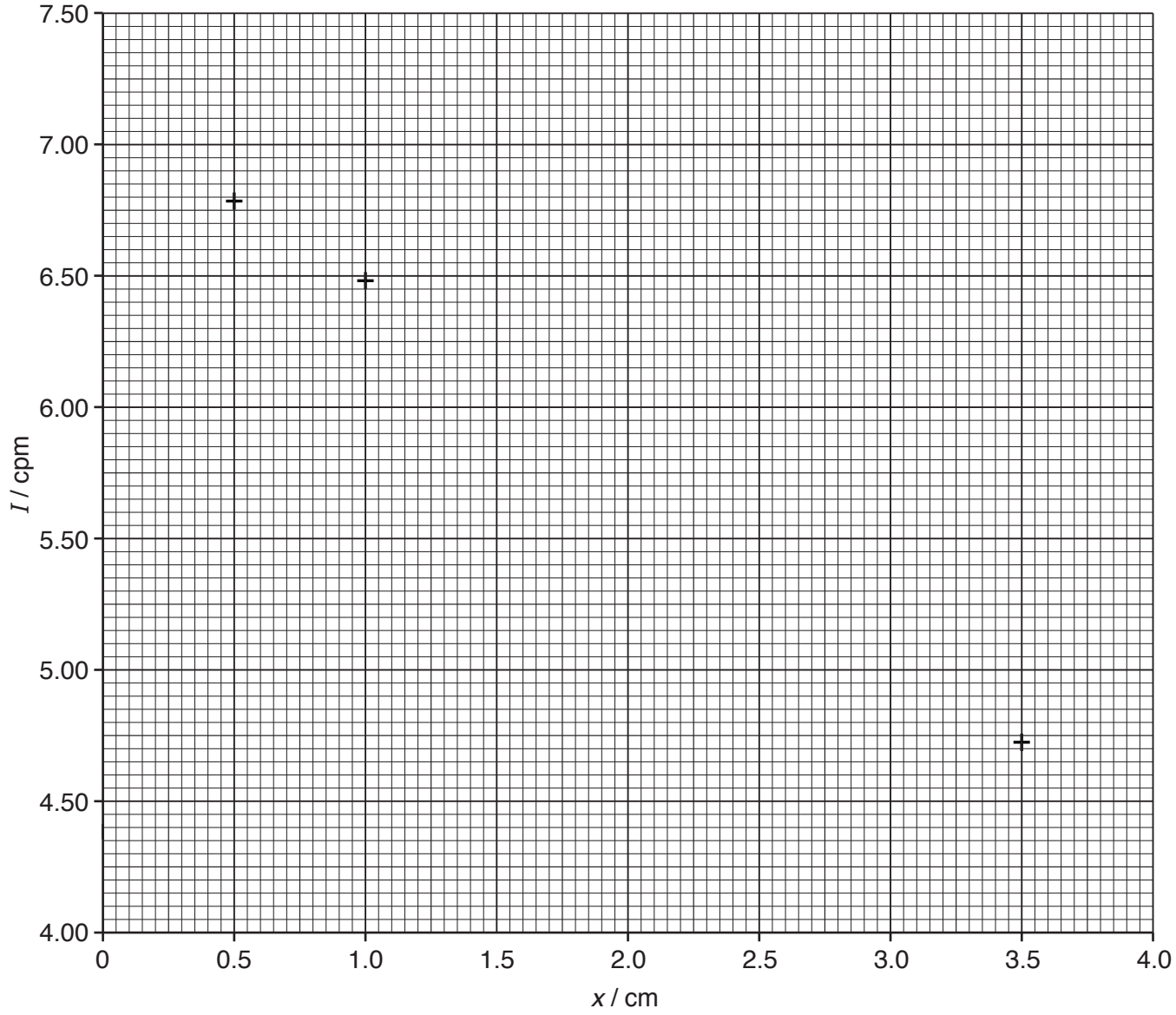

Fig. 4.3

(d) (i) Use the value of μ calculated in **(c)(iii)** to calculate the half-thickness of lead.

half-thickness = ... cm **[3]**

(d) (ii) Suggest and explain which of the methods used, in parts **(b)(ii)** and **(d)(i)**, to determine the half-thickness is the most reliable.

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END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).