Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0131112034

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 30.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **8** pages.

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1 Two parallel metal plates, each of area A, are separated by a small distance d, as shown in Fig. 1.1.

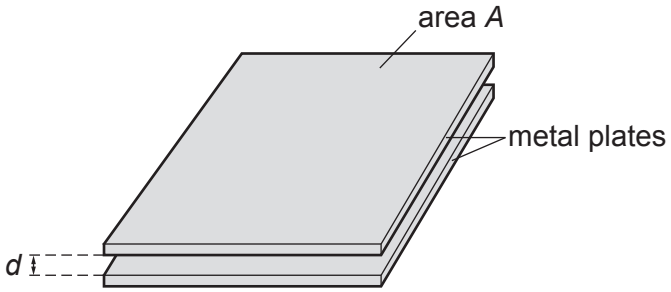

Fig. 1.1 (not to scale)

The plates are initially charged using a power supply.

The plates are then connected to an uncharged capacitor. The potential difference V across the capacitor is measured.

It is suggested that V is related to d by the relationship

$$\frac{W}{V} = 1 + \frac{Cd}{KA}$$

where C is the capacitance of the capacitor, and K and W are constants.

Plan a laboratory experiment to test the relationship between V and d.

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for K and W.

In your plan you should include:

- 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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[15]

2 A student investigates the relationship between the luminosity L of a star and its mass M for a set of stars known as main-sequence stars.

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

$$L = SZM^n$$

where S is the luminosity of the Sun, and Z and n are constants.

(a) A graph is plotted of lg L on the y-axis against lg M on the x-axis.

Determine expressions for the gradient and y-intercept.

gradient = ...

y-intercept = ...
[1]

(b) Values of M and L are given in Table 2.1.

Table 2.1

$M / 10^{30}$ kg	$L / 10^{28}$ W	lg ($M / 10^{30}$ kg)	lg ($L / 10^{28}$ W)
4.8 ± 0.4	1.4		
6.4 ± 0.4	3.1		
12 ± 2	32		
23 ± 2	350		
43 ± 4	3600		
91 ± 4	66 000		

Calculate and record values of lg ($M / 10^{30}$ kg) and lg ($L / 10^{28}$ W) in Table 2.1.
Include the absolute uncertainties in lg ($M / 10^{30}$ kg). [2]

(c) **(i)** Plot a graph of lg ($L / 10^{28}$ W) against lg ($M / 10^{30}$ kg).
Include error bars for lg ($M / 10^{30}$ kg). [2]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Label both lines. [2]

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

gradient = ... [2]

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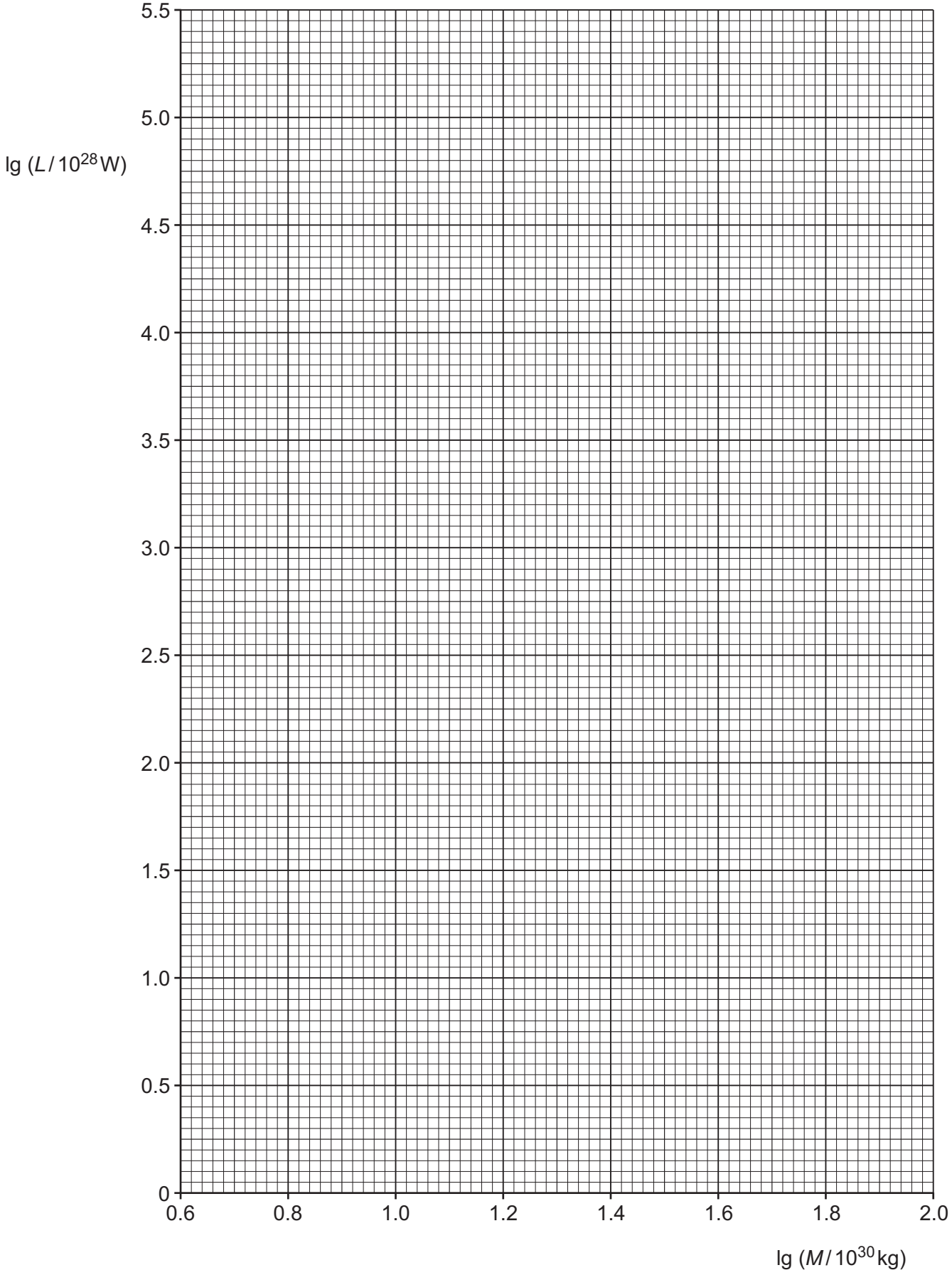
lg (L / 10^{28} W)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
lg (M / 10^{30} kg)

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

y-intercept = ... [2]

(d) Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine the values of n and Z. Include the absolute uncertainties in your values. You need not be concerned with units.

Data: $S = 3.85 \times 10^{26}$ W

n = ...

Z = ...
[3]

(e) Another main-sequence star has a mass of 3.0×10^{30} kg.

Determine the luminosity L of this star.

L = ... W [1]

[Total: 15]

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