



# Cambridge International AS & A Level

CANDIDATE  
NAME

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## 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

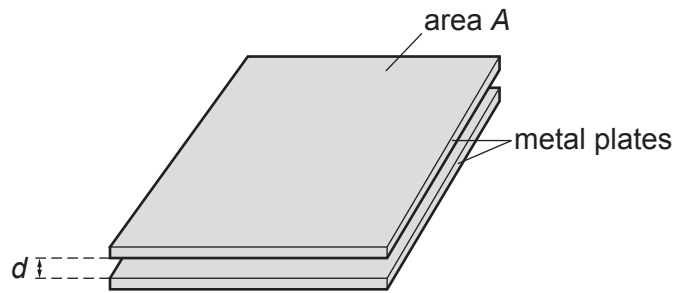
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction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

- 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.

Diagram

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- 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)
$4.8 \pm 0.4$	1.4		
$6.4 \pm 0.4$	3.1		
$12 \pm 2$	32		
$23 \pm 2$	350		
$43 \pm 4$	3600		
$91 \pm 4$	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).

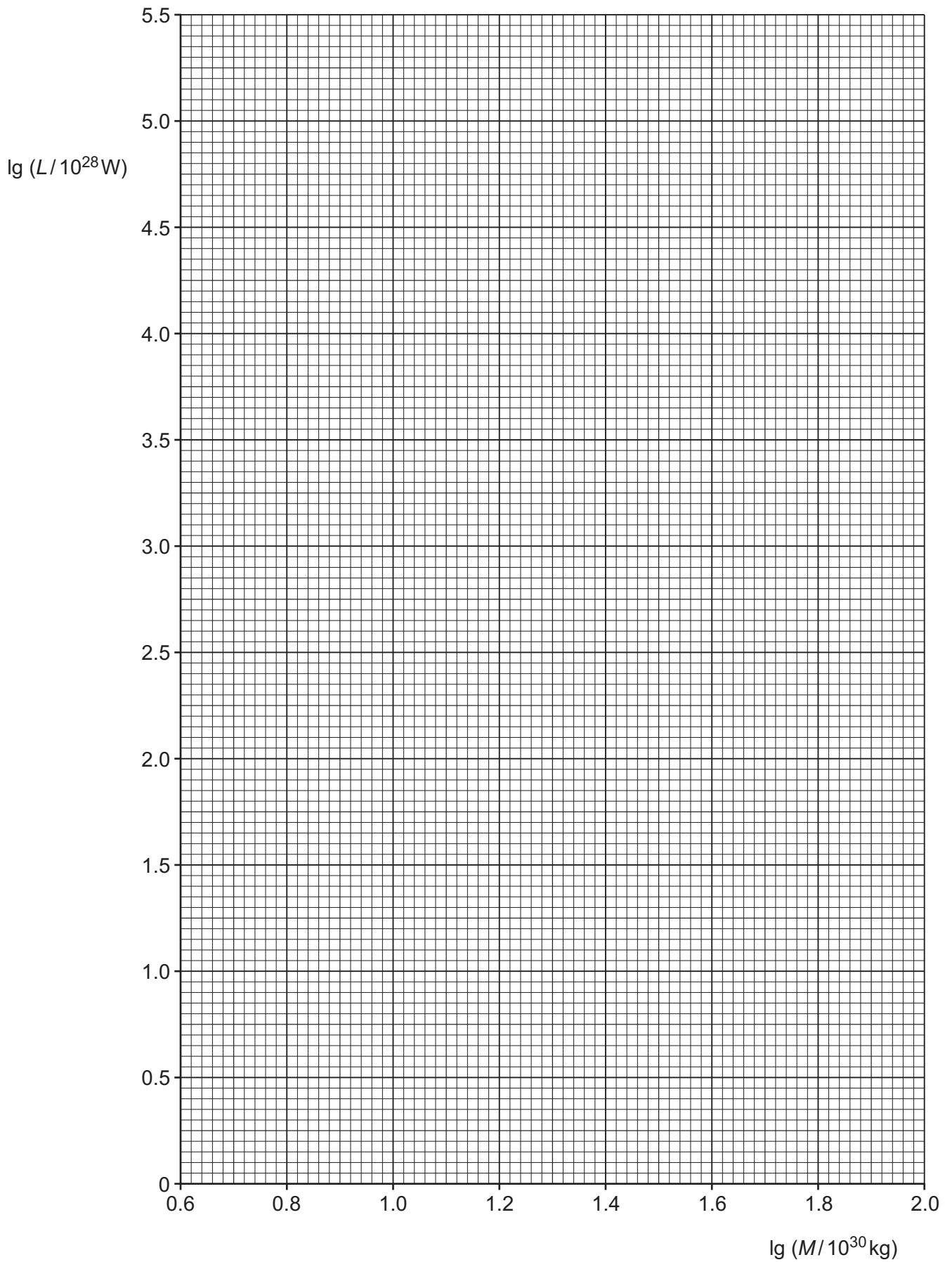
[2]

(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]



- (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:  $S = 3.85 \times 10^{26} \text{ W}$

$n = \dots\dots\dots$

$Z = \dots\dots\dots$  [3]

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

Determine the luminosity  $L$  of this star.

$L = \dots\dots\dots \text{ W}$  [1]

[Total: 15]