



# Cambridge International AS & A Level

CANDIDATE  
NAME

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CENTRE  
NUMBER

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CANDIDATE  
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## PHYSICS

9702/52

Paper 5 Planning, Analysis and Evaluation

October/November 2021

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 A student investigates the extension of a spring supporting a wooden strip, as shown in Fig. 1.1.

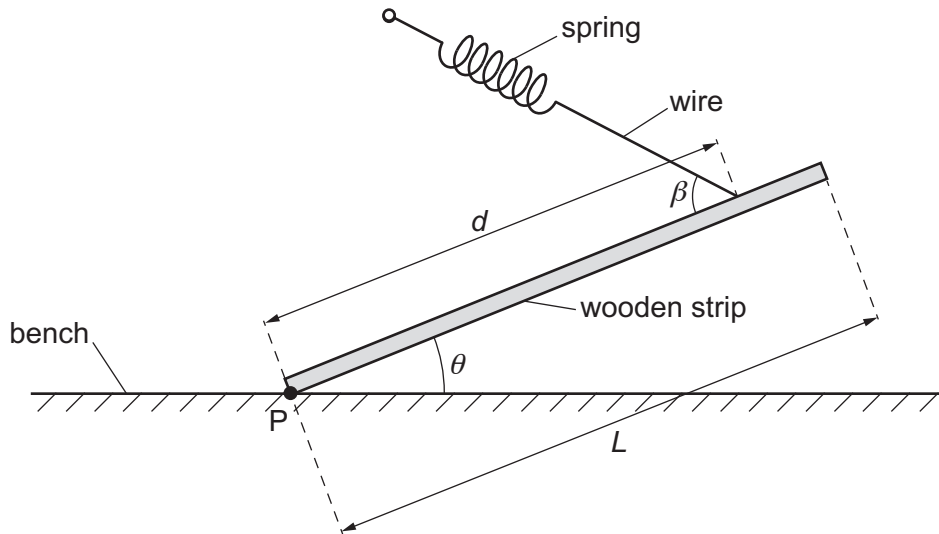


Fig. 1.1

One end of the strip is at point P. The strip has length  $L$  and is at an angle  $\theta$  to the bench.

The spring is attached to the strip by a wire at a distance  $d$  from point P. The wire is at an angle  $\beta$  to the strip. The spring has extension  $x$ .

It is suggested that the relationship between  $x$  and  $\theta$  is

$$\frac{WL}{2} \cos \theta = kxd \sin \beta$$

where  $k$  is the spring constant of the spring and  $W$  is a constant.

Design a laboratory experiment to test the relationship between  $x$  and  $\theta$ . Explain how your results could be used to determine a value for  $W$ .

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.

**Diagram**

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- 2 A Geiger–Müller (G–M) tube is a device that can detect beta-radiation. A student places paper between a radioactive source emitting beta-radiation and a G–M tube, as shown in Fig. 2.1.

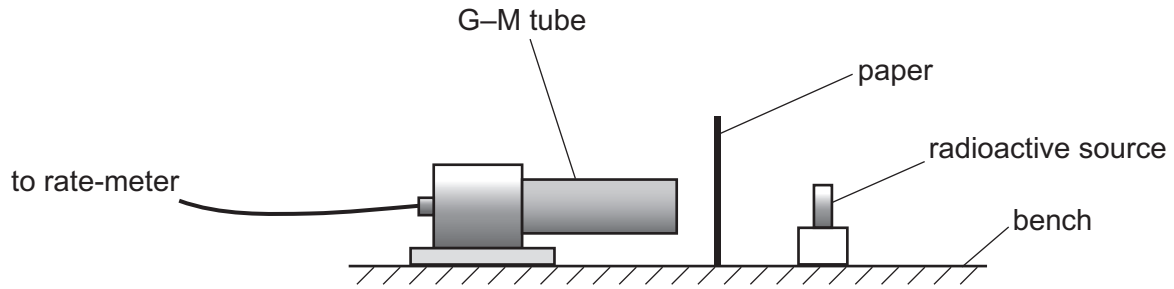


Fig. 2.1

The G–M tube is connected to a rate-meter which records the count rate  $R$ .

The thickness  $t$  of the paper is measured in two different places using a micrometer.

The student repeats the experiment for different thicknesses of paper.

It is suggested that  $R$  and  $t$  are related by the equation

$$R = R_0 e^{-\mu t}$$

where  $R_0$  is the count rate without any paper and  $\mu$  is a constant.

- (a) A graph is plotted of  $\ln R$  on the  $y$ -axis against  $t$  on the  $x$ -axis.

Determine expressions for the gradient and  $y$ -intercept.

gradient = .....

$y$ -intercept = .....

[1]

(b) The two measurements of thickness are  $t_1$  and  $t_2$ . Values of  $t_1$ ,  $t_2$  and  $R$  are given in Table 2.1.

**Table 2.1**

$t_1/\text{mm}$	$t_2/\text{mm}$	average $t/\text{mm}$	$R/\text{s}^{-1}$	$\ln(R/\text{s}^{-1})$
0.19	0.13		47.7	
0.22	0.28		44.0	
0.39	0.45		38.2	
0.58	0.54		34.3	
0.64	0.68		31.7	
0.78	0.74		29.7	

Calculate and record values of average  $t/\text{mm}$  and  $\ln(R/\text{s}^{-1})$  in Table 2.1.

Include the absolute uncertainties in average  $t$ .

[2]

(c) (i) Plot a graph of  $\ln(R/\text{s}^{-1})$  against average  $t/\text{mm}$ .

Include error bars for average  $t$ .

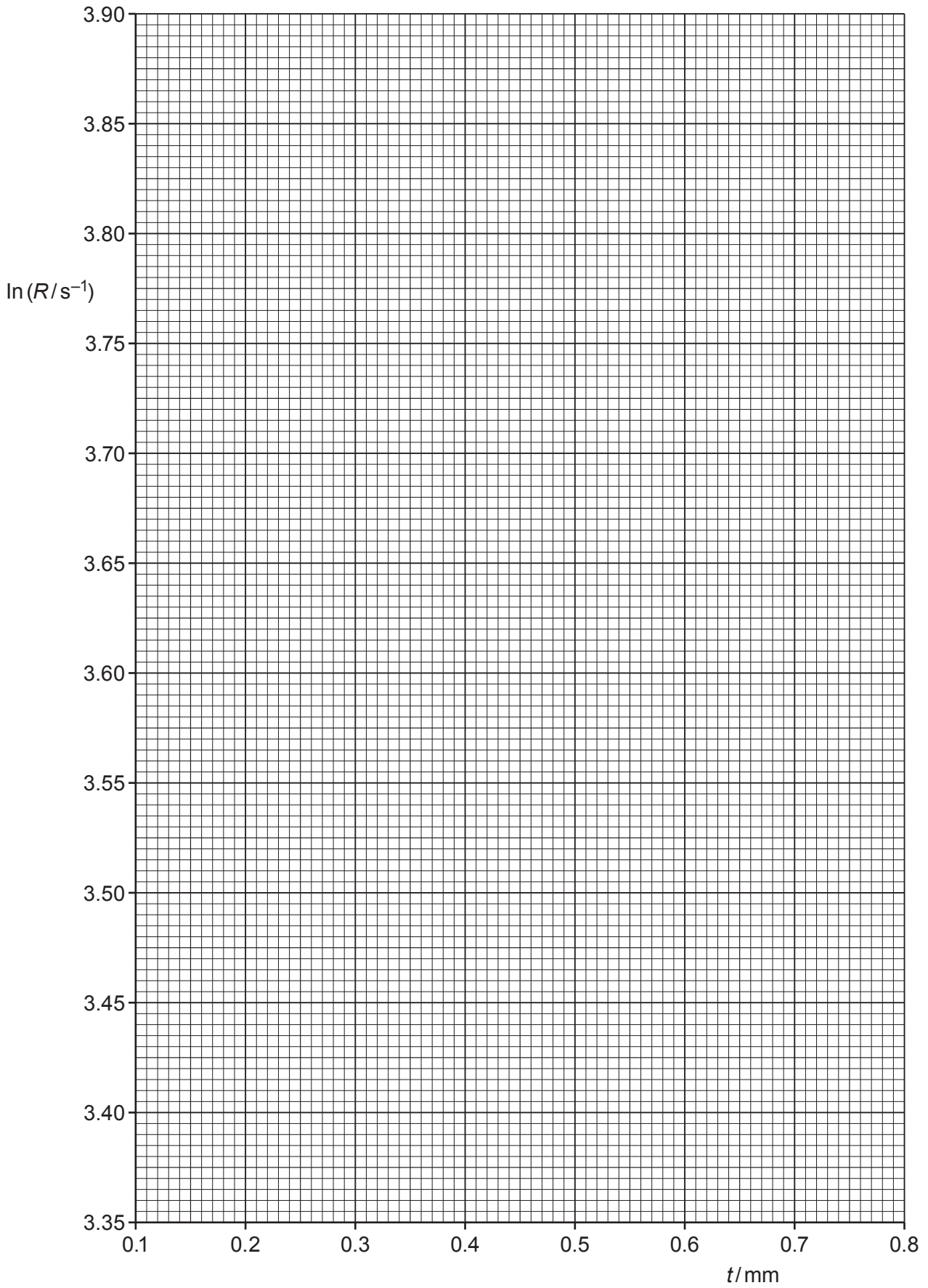
[2]

(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]



- (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  $\mu$  and  $R_0$ . Include the absolute uncertainties in your values and include appropriate units.

$\mu$  = .....  
 $R_0$  = ..... [3]

- (e) The experiment is repeated using a different thickness of paper.

Determine the value of  $t$  that would give a value of  $R$  of  $20.0 \text{ s}^{-1}$ .

$t$  = ..... mm [1]

[Total: 15]

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