Cambridge Assessment International Education

Cambridge International A Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

7056615085

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.

DC (ST/CT) 201467/2

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

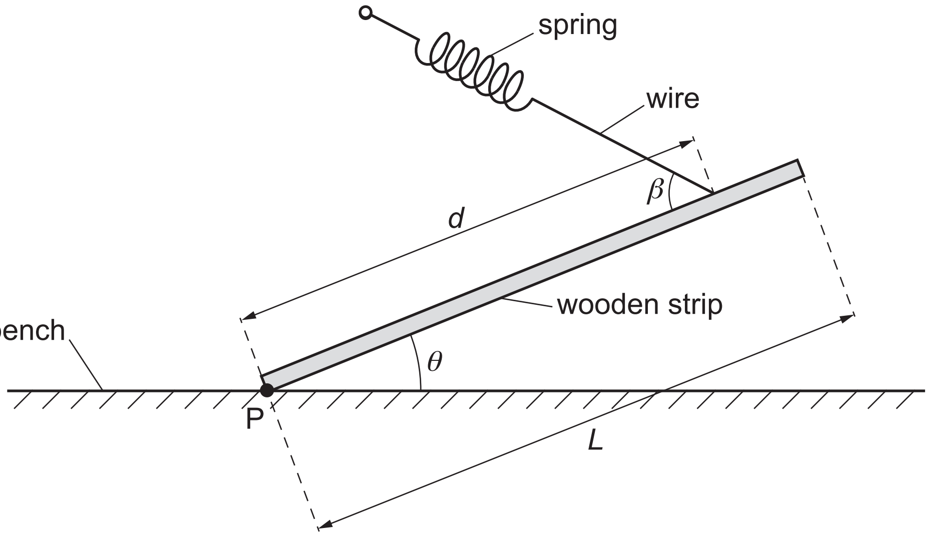

Fig. 1.1

One end of the strip is at point P. The strip has length L and is at an angle θ 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 β to the strip. The spring has extension x.

It is suggested that the relationship between x and θ 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 θ.
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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[15]

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.

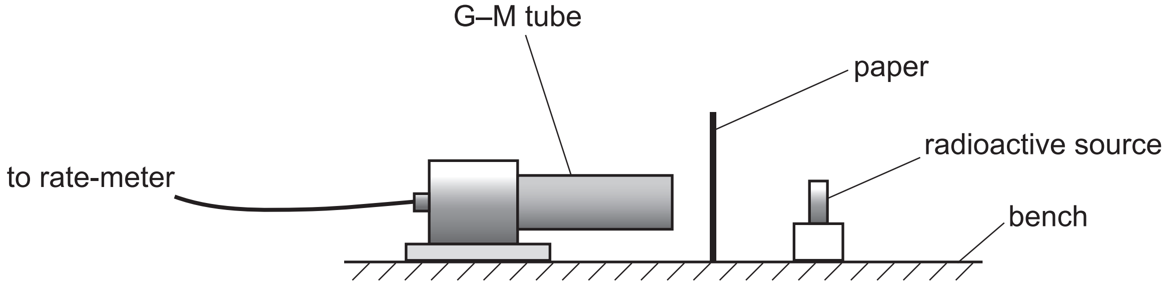


Fig. 2.1

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 μ 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 / mm	t_2 / mm	average t / mm	R / s^{-1}	$\ln(R / s^{-1})$
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	

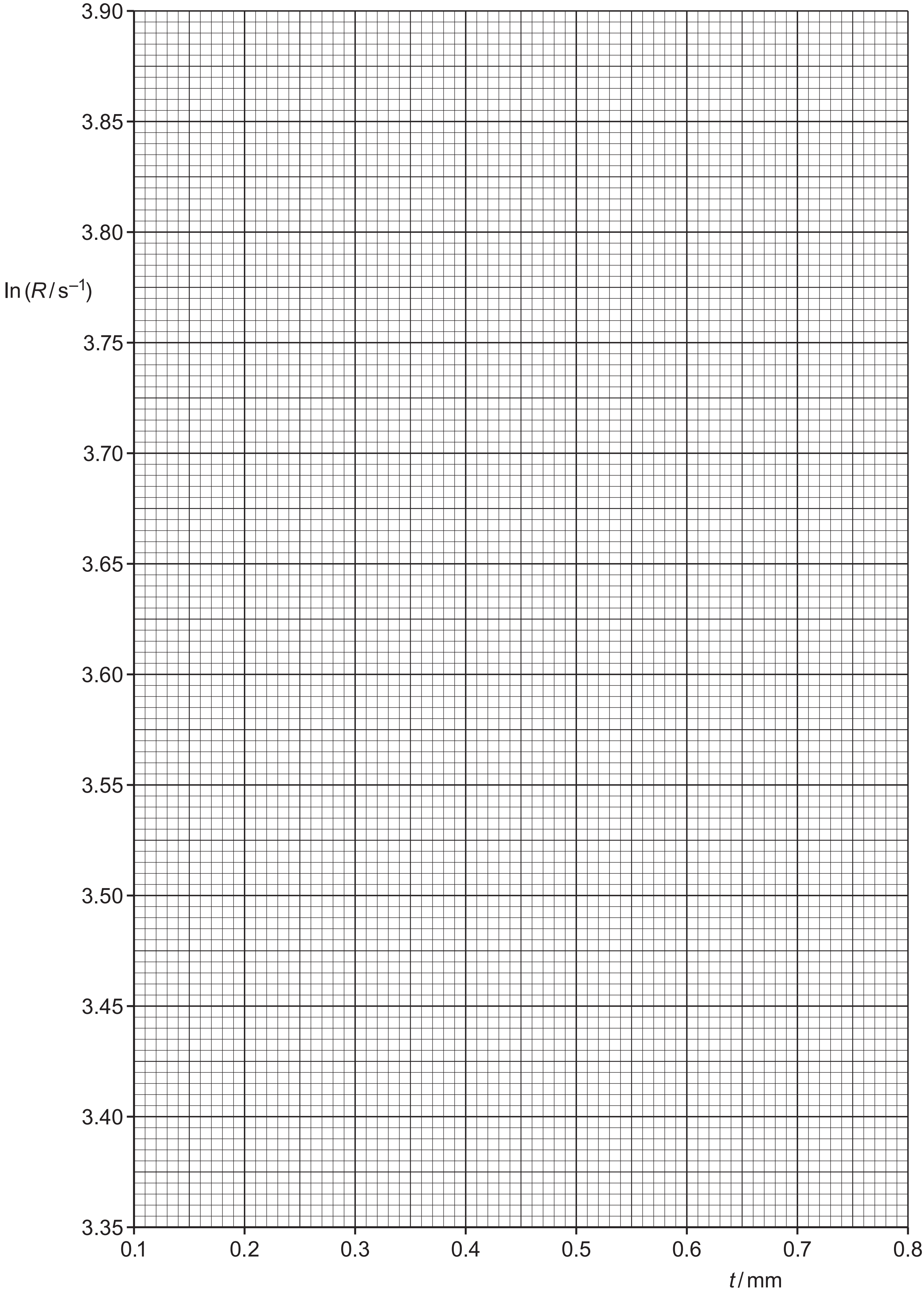
Calculate and record values of average t / mm and $\ln(R / s^{-1})$ in Table 2.1.
Include the absolute uncertainties in average t. [2]

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


3.90
3.85
3.80
ln (R / s⁻¹)
3.75
3.70
3.65
3.60
3.55
3.50
3.45
3.40
3.35
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
t / mm

(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 μ and R_0. Include the absolute uncertainties in your values and include appropriate units.

μ = ...

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 $20.0\,s^{-1}$.

t = ... mm [1]

[Total: 15]