Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5004010739

PHYSICS **9702/51**

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

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1 A student investigates the current in a coil and a resistor connected in series, as shown in Fig. 1.1.

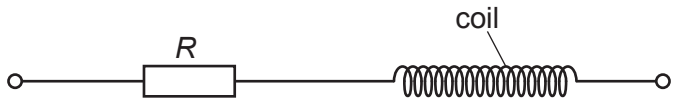

Fig. 1.1

The student connects a high-voltage d.c. power supply and a switch across the series combination.

When the switch is closed, it takes time t for the current in the resistor of resistance R to reach a maximum value. The time t is a few milliseconds.

There are a number of different unmarked resistors available.

It is suggested that the relationship between t and R is

$$t = \frac{KN^2A}{LR}$$

where N is the number of turns of wire on the coil, A is the cross-sectional area of the coil, L is the length of the coil and K is a constant.

Design a laboratory experiment to test the relationship between t and R.
Explain how your results could be used to determine a value for K.

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.

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Diagram

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2 A student investigates the collision of two gliders A and B on a linear air-track. A card is attached to glider B, as shown in Fig. 2.1.

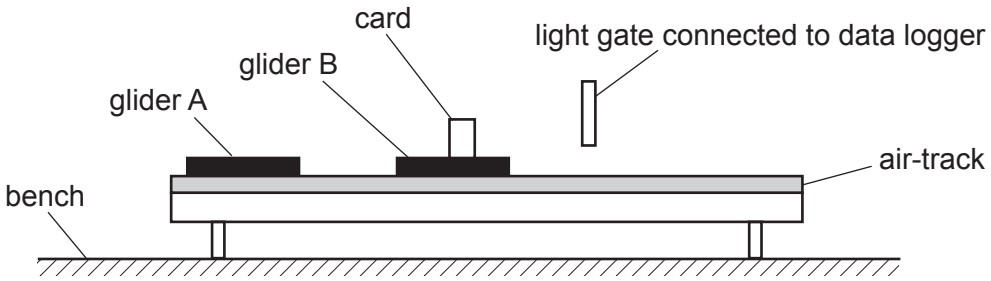

Fig. 2.1

Glider B has a mass *M*. A mass *m* is added to glider B.

Glider A travels at a constant velocity *u* towards the stationary glider B. The gliders then collide and move together towards the light gate.

The card passes through the light gate which is connected to a data logger. The student records the velocity *v* of the two gliders from the data logger.

The student changes the mass *m* and repeats the experiment.

It is suggested that *v* and *m* are related by the equation

$$Au = (M + m + A)v$$

where *A* is the mass of glider A.

(a) A graph is plotted of $\frac{1}{v}$ on the *y*-axis against $(M + m)$ on the *x*-axis.

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

gradient = ...

y-intercept = ...

[1]

(b) Values of m and v are given in Table 2.1.

The value of M is 330 g ± 5%.
Each value of m has a percentage uncertainty of ± 5%.

Table 2.1

m / g	$(M + m)$ / g	v / cm s^{-1}	$\frac{1}{v}$ / s cm^{-1}
50		4.42	
150		3.92	
250		3.40	
350		3.02	
500		2.58	
600		2.33	

Calculate and record values of $(M + m)$ / g and $\frac{1}{v}$ / s cm^{-1} in Table 2.1.
Include the absolute uncertainties in $(M + m)$. [2]

(c) (i) Plot a graph of $\frac{1}{v}$ / s cm^{-1} against $(M + m)$ / g.

Include error bars for $(M + m)$. [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]

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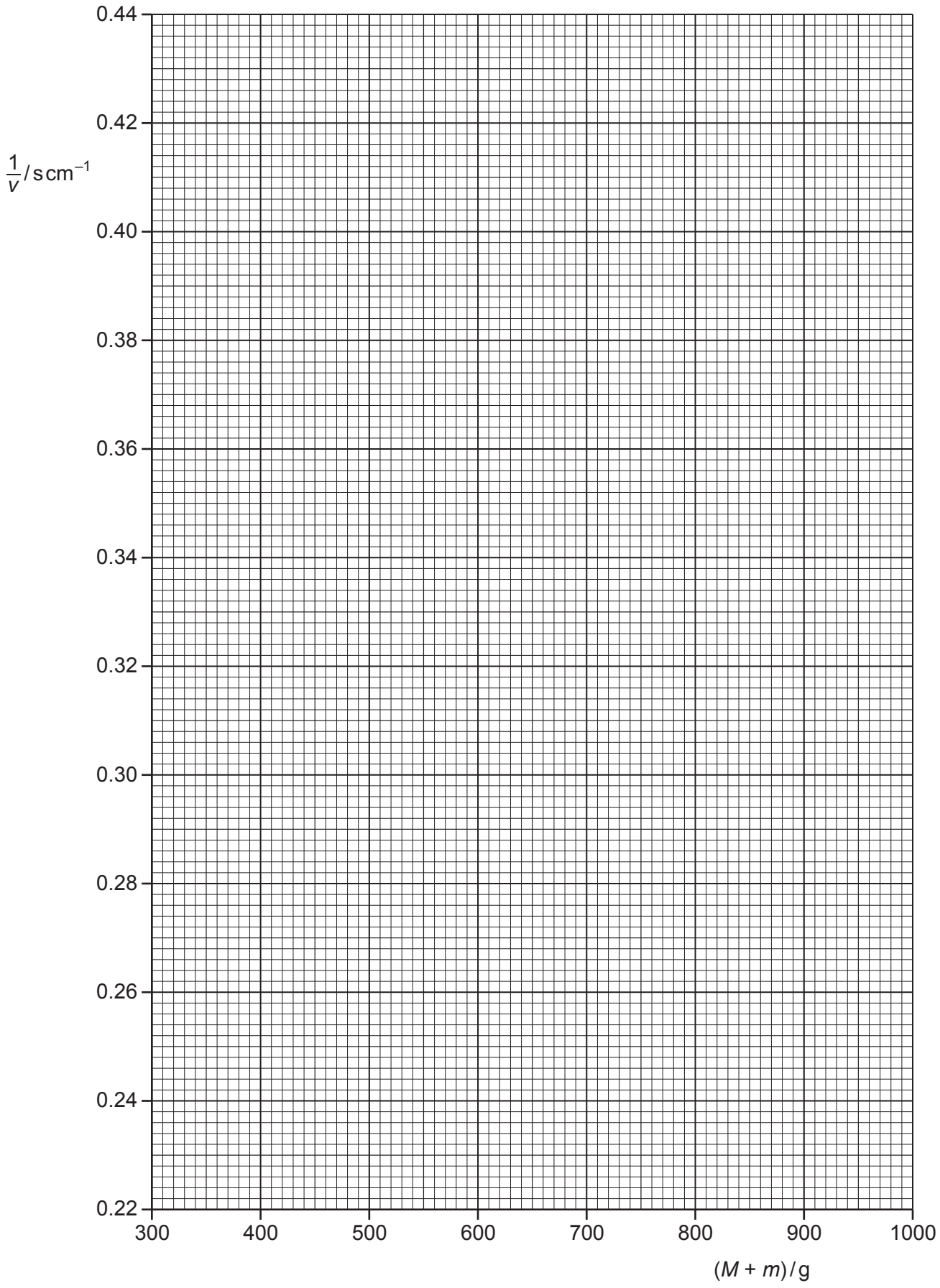
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
1/v / s cm⁻¹
300
400
500
600
700
800
900
1000
(M + m) / g

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

y-intercept = ... [2]

(d) (i) Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine the values of u and A. Include appropriate units.

u = ...

A = ...
[2]

(ii) Determine the percentage uncertainty in A.

percentage uncertainty in A = ... % [1]

(e) The experiment is repeated. Determine the value of m that would give a velocity v of $2.0\,\text{cm}\,\text{s}^{-1}$.

m = ... g [1]

[Total: 15]

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