



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9702/53

May/June 2021

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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 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.

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.

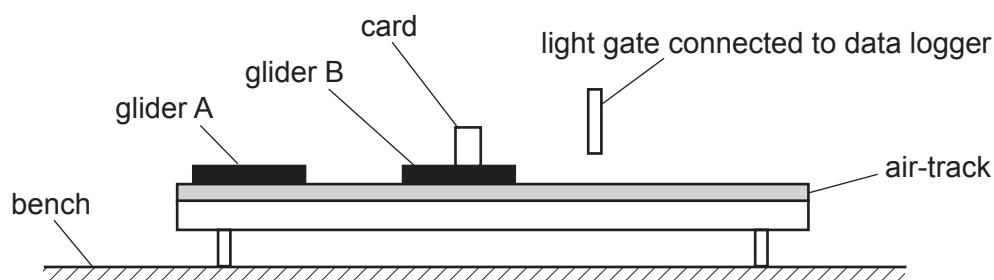


Fig. 2.1

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 $330\text{ g} \pm 5\%$.

Each value of m has a percentage uncertainty of $\pm 5\%$.

Table 2.1

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

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

[2]

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

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

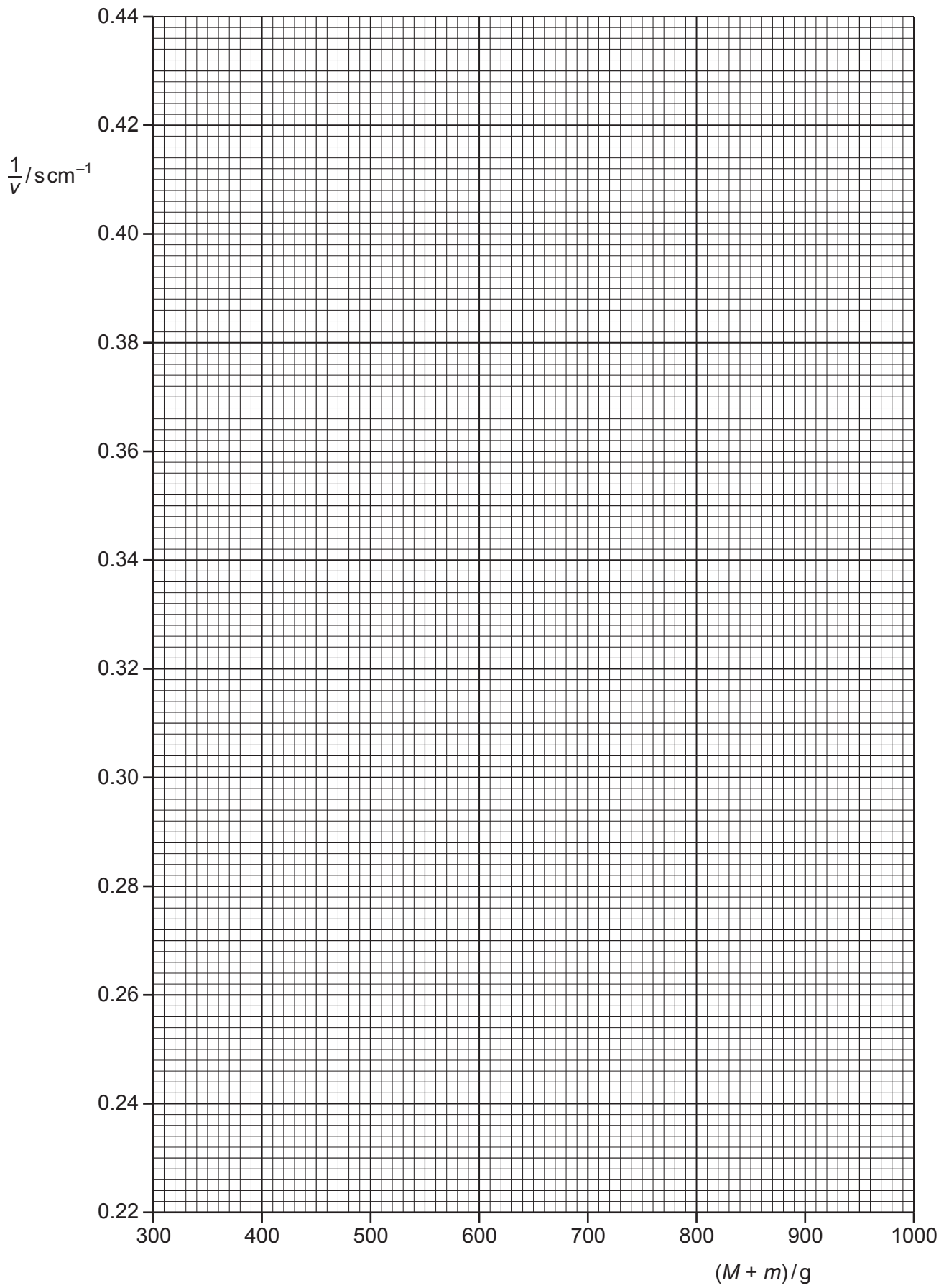
[2]

(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]



- (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 cm s^{-1} .

m = g [1]

[Total: 15]