



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9702/52

February/March 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 **12** pages. Any blank pages are indicated.

- 1 A student investigates the vertical oscillations of a solid cylinder which floats in cooking oil. Fig. 1.1 shows a cylinder of radius r .

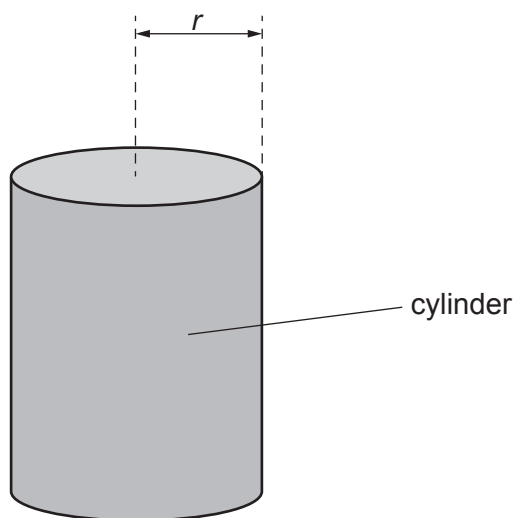


Fig. 1.1

The student places the cylinder of mass m in the oil. The cylinder is displaced vertically from its equilibrium position and released so that it oscillates. The period T of the oscillations is determined.

A number of cylinders of different mass are available.

It is suggested that the relationship between T and m is

$$T = 2\sqrt{\frac{\pi m}{\sigma K r^2}}$$

where σ is the density of the oil and K is a constant.

Design a laboratory experiment to test the relationship between T and m .

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, as shown in Fig. 2.1.

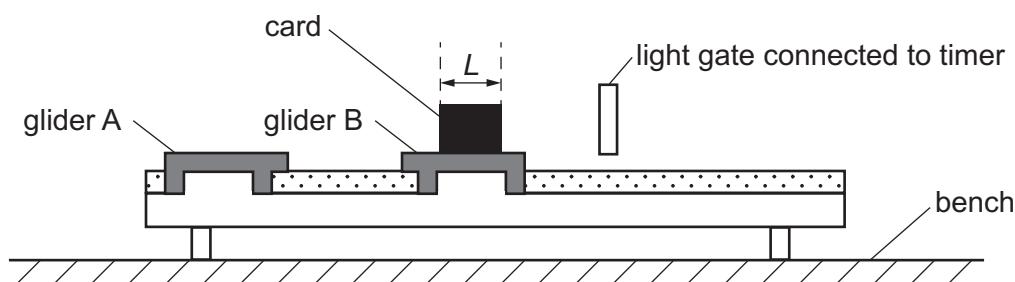


Fig. 2.1

The light gate is connected to a timer. A card of length L is attached to glider B. The mass of glider B and the card is m . Glider B is initially at rest.

The student releases glider A so that it travels at a constant velocity u towards the stationary glider B. The gliders collide and then separate.

The card on glider B passes through the light gate. The student records the time t for the card to pass through the light gate from the timer.

The student changes the mass of glider B and repeats the experiment.

It is suggested that the velocity v of glider B as it passes through the light gate and m are related by the equation

$$v = \frac{2uA}{m + A}$$

where A is the mass of glider A.

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

Determine expressions for the gradient and y -intercept.

gradient =

y -intercept =

[1]

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

Table 2.1

m/g	t/s	$\frac{1}{v}/\text{s cm}^{-1}$
271	0.23 ± 0.01	
369	0.26 ± 0.01	
490	0.31 ± 0.01	
632	0.36 ± 0.01	
741	0.40 ± 0.01	
840	0.44 ± 0.01	

Calculate and record values of $\frac{1}{v}/\text{s cm}^{-1}$ in Table 2.1 where

$$\frac{1}{v} = \frac{t}{L}$$

and $L = 5.0 \pm 0.1 \text{ cm}$.

Include the absolute uncertainties in $\frac{1}{v}$. [2]

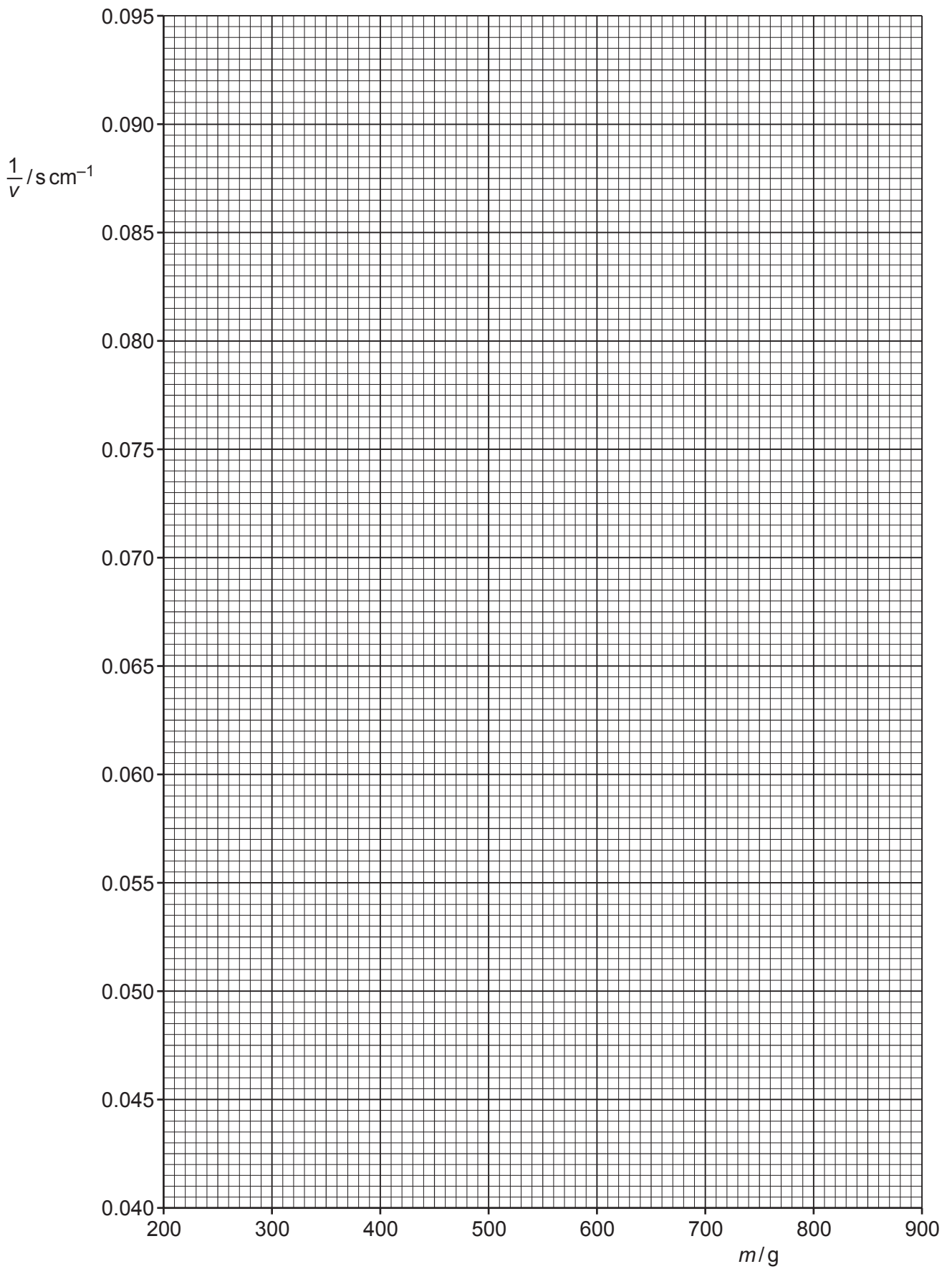
(c) (i) Plot a graph of $\frac{1}{v}/\text{s cm}^{-1}$ against m/g .

Include error bars for $\frac{1}{v}$. [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 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 mass m of glider B and the card when t has a value of 0.50 s.

m = g [1]

[Total: 15]

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