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Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*8608135898*

**PHYSICS** **9702/52**

Paper 5 Planning, Analysis and Evaluation **February/March 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 **12** pages. Any blank pages are indicated.

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**[Turn over**

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**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*.

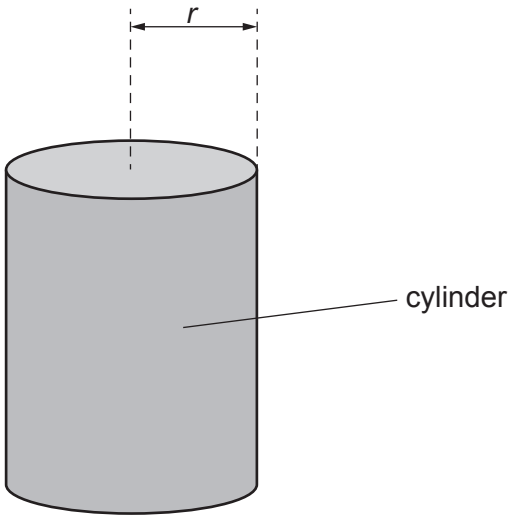


**Fig. 1.1**

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 $\sigma$ 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.

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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, as shown in Fig. 2.1.

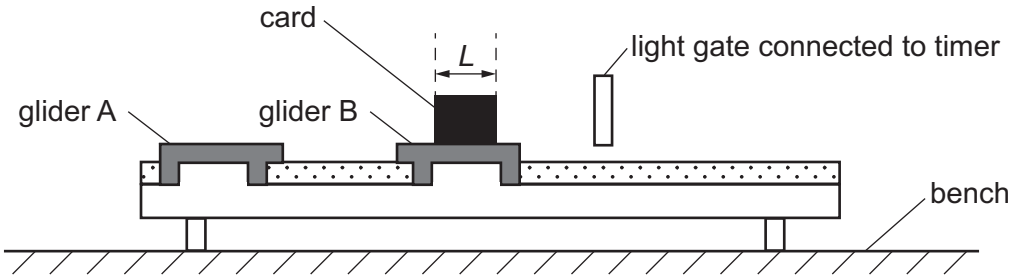


**Fig. 2.1**

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]

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**[Turn over**

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

**Table 2.1**

| $m$ / g | $t$ / s | $\frac{1}{v}$ / 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 $\frac{1}{v}$ / s cm$^{-1}$ in Table 2.1 where

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

and $L$ = 5.0 ± 0.1 cm.

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

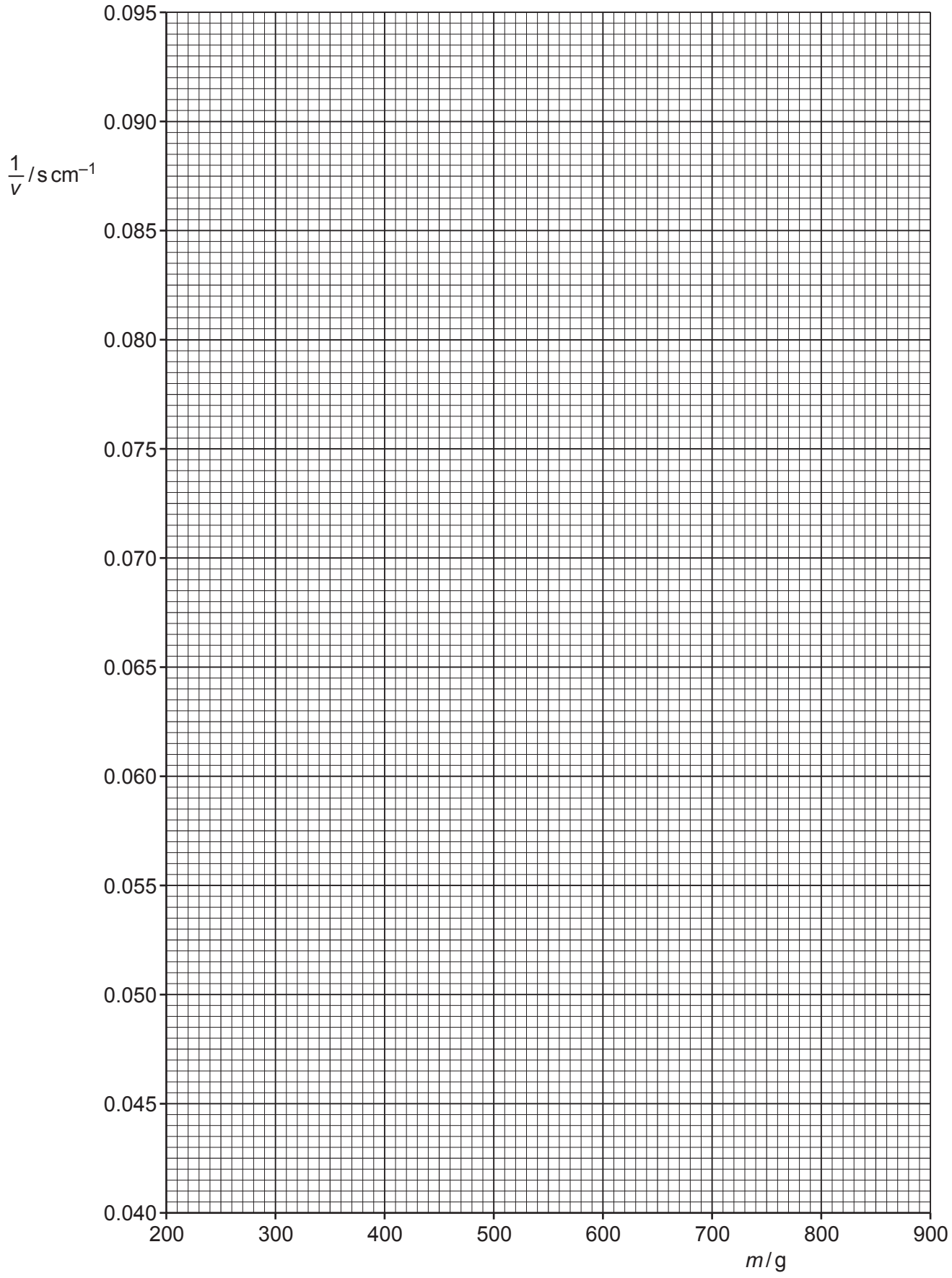
**(c)** **(i)** Plot a graph of $\frac{1}{v}$ / s cm$^{-1}$ against $m$ / g.

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]


0.095
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
1/v / s cm−1
200
300
400
500
600
700
800
900
m / g

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**(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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