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Forename(s)

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Candidate signature

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I declare this is my own work.

# A-level PHYSICS

## Paper 3 Section A

Time allowed: The total time for both sections of this paper is 2 hours. You are advised to spend approximately 70 minutes on this section.

### Materials

For this paper you must have:

- a pencil and a ruler
- a scientific calculator
- a Data and Formulae Booklet
- a protractor.

### Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

### Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 45.
- You are expected to use a scientific calculator where appropriate.
- A Data and Formulae Booklet is provided as a loose insert.

For Examiner's Use

| Question     | Mark |
|--------------|------|
| 1            |      |
| 2            |      |
| 3            |      |
| 4            |      |
| <b>TOTAL</b> |      |



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**7408/3A**

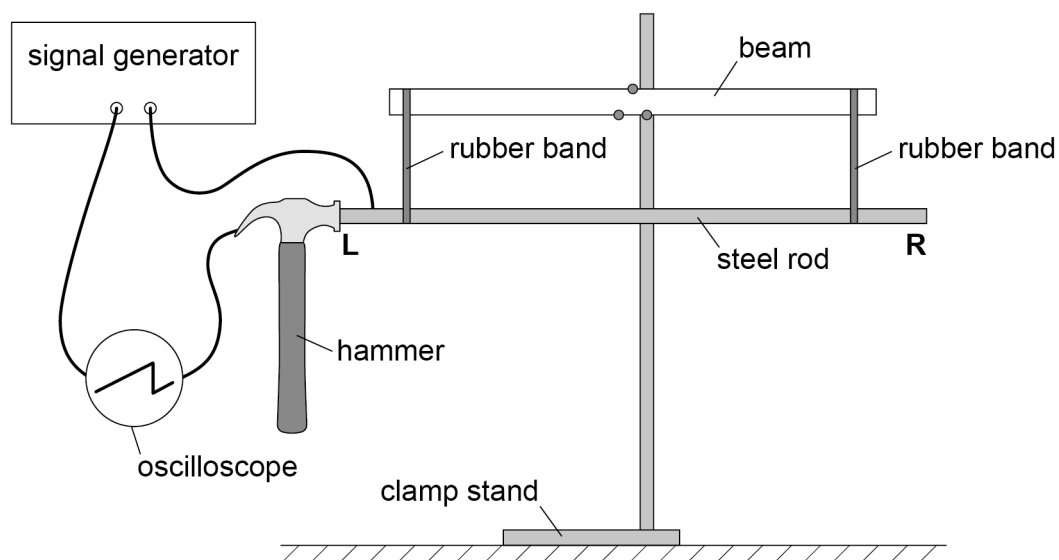
## Section A

Answer **all** questions in this section.

0 1

**Figure 1** shows apparatus used to measure the speed of sound in a steel rod.

**Figure 1**



The steel rod is suspended from a beam using rubber bands. When the hammer is in contact with the end **L** of the steel rod, a circuit is completed and the signal generator is connected to the oscilloscope.

**Figure 2** shows the waveform then displayed on the oscilloscope.

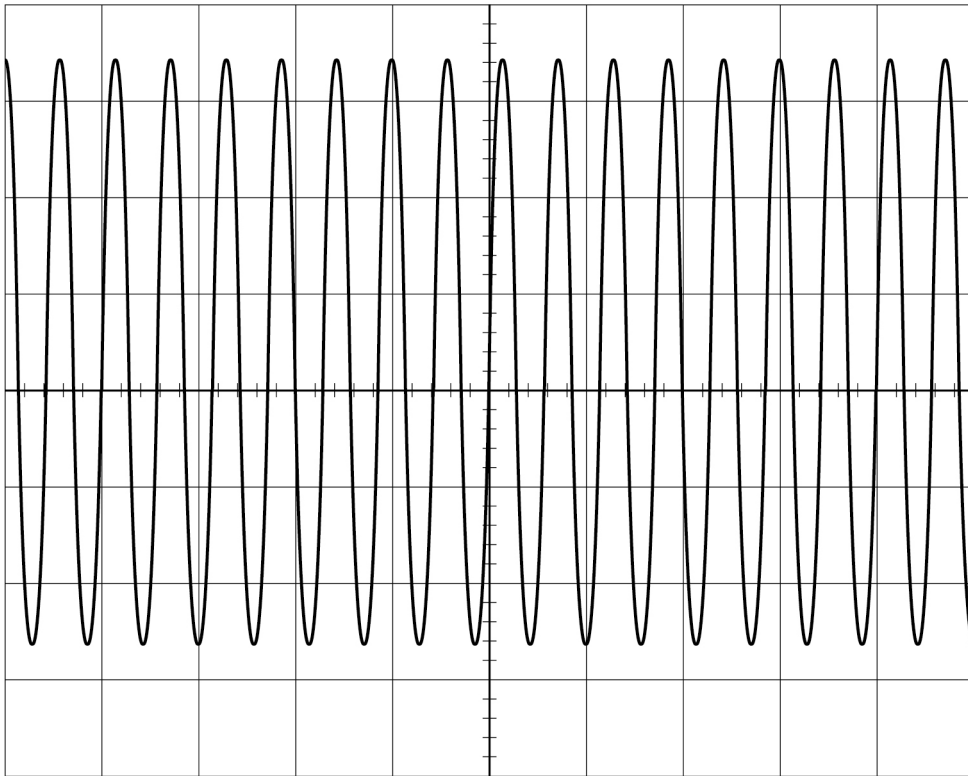
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Figure 2



0 1 . 1

Which control on the oscilloscope should be used to centre the trace vertically on the screen?

Tick (✓) **one** box.

[1 mark]

X-shift

☐

Y-gain

☐

Y-shift

☐

Question 1 continues on the next page

Turn over ►



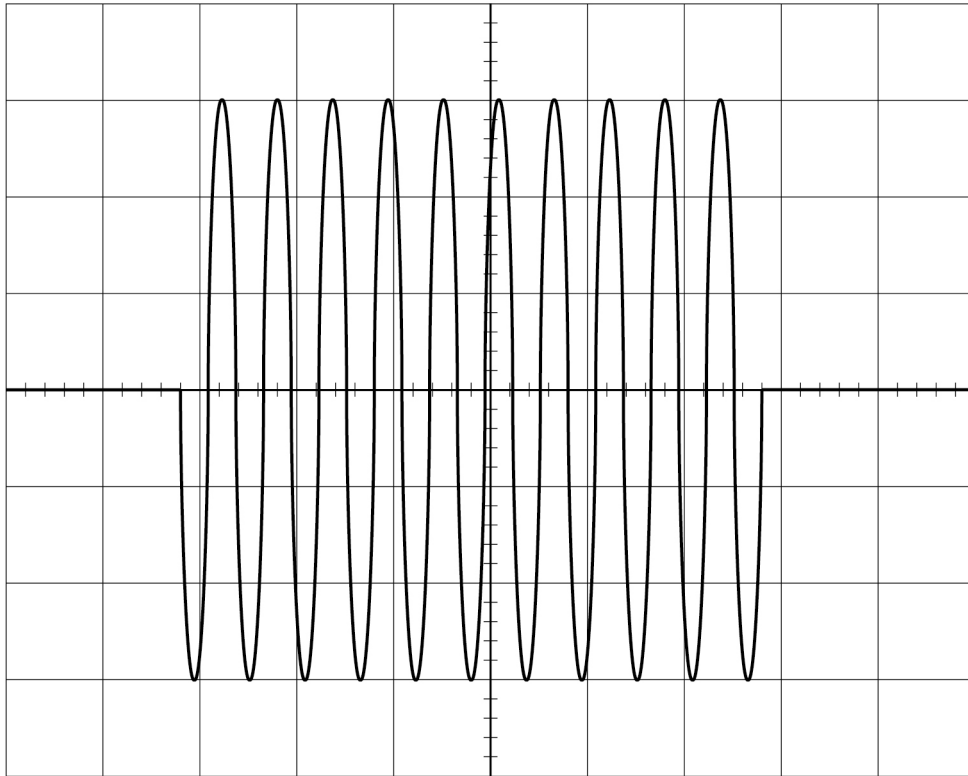
When the hammer hits end **L**, a sound wave travels along the steel rod and is reflected at end **R**.

When the wave returns to **L** the rod bounces away from the hammer and the circuit is broken.

**Figure 3** shows the waveform produced by the brief contact between the hammer and **L**.

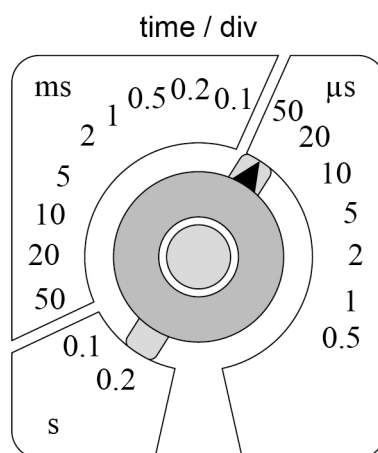
Note that the waveform has now been centred vertically.

**Figure 3**



**Figure 4** shows the time-base setting of the oscilloscope.

**Figure 4**

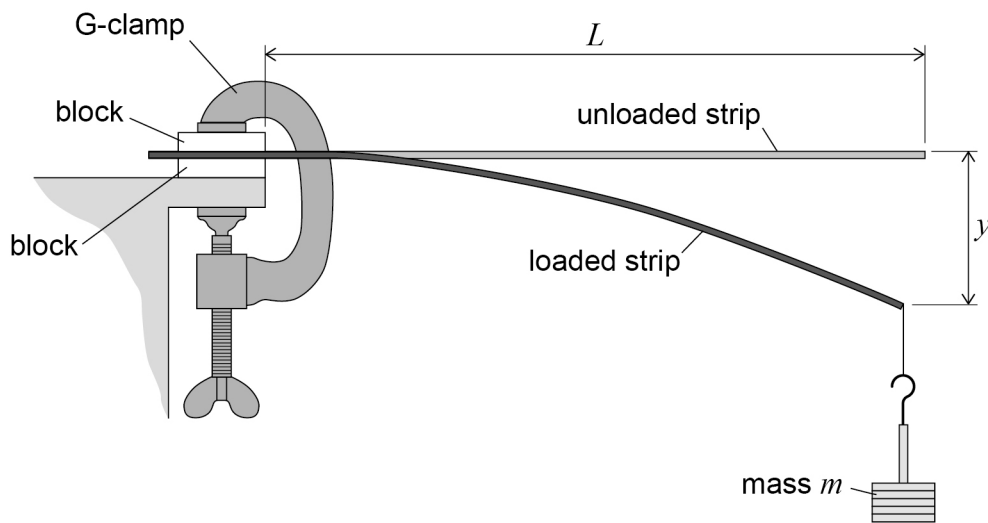




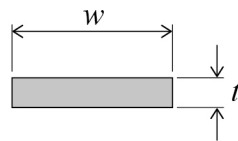
0 2

**Figure 5** shows a strip of steel of rectangular cross-section clamped at one end. The strip extends horizontally over the edge of a bench.

**Figure 5**



end view of unloaded steel strip



0 2 . 1

A mass  $m$  is suspended from the free end of the strip.

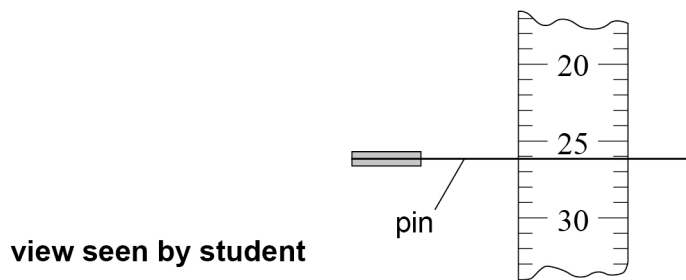
This produces a vertical displacement  $y$ .

A student intends to measure  $y$  with the aid of a horizontal pin fixed to the free end of the steel strip.

She positions a clamped vertical ruler behind the pin, as shown in **Figure 6**.

**Figure 6**

plan view



Explain a procedure to avoid parallax error when judging the reading indicated by the position of the pin on the ruler.

You may add detail to **Figure 6** to illustrate your answer.

**[2 marks]**

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Question 2 continues on the next page

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7

Turn over for the next question

Turn over ►



**0 3**

Conductive putty can easily be formed into different shapes to investigate the effect of shape on electrical resistance.

**0 3 . 1**

A student uses vernier callipers to measure the diameter  $d$  of a uniform cylinder made of the putty.

Suggest **one** problem with using callipers to make this measurement.

**[1 mark]**


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**0 3 . 2**

**Table 1** shows the calliper measurements made by a student.

**Table 1**

| $d_1 / \text{mm}$ | $d_2 / \text{mm}$ | $d_3 / \text{mm}$ | $d_4 / \text{mm}$ | $d_5 / \text{mm}$ |
|-------------------|-------------------|-------------------|-------------------|-------------------|
| 34.5              | 34.2              | 32.9              | 33.4              | 34.0              |

Show that the percentage uncertainty in  $d$  is about 2.4%.  
Assume that all the data are valid.

**[2 marks]**

|   |   |   |   |
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The length of the cylinder is  $71 \pm 2$  mm.

Determine the uncertainty, in  $\text{mm}^3$ , in the volume of the cylinder.

**[4 marks]**

uncertainty = \_\_\_\_\_  $\text{mm}^3$

**Question 3 continues on the next page**

**Turn over ►**



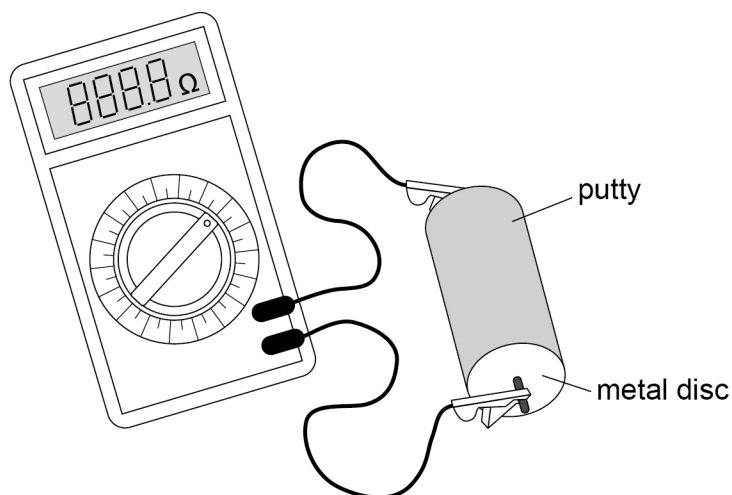
0 3 . 4

A student is given some putty to form into cylinders.

To find the resistance of a cylinder, metal discs are placed in contact with the ends of the cylinder and connected to a resistance meter.

**Figure 7** shows the apparatus.

**Figure 7**



The student forms the putty into cylinders of different lengths, each of volume  $5.83 \times 10^{-5} \text{ m}^3$ .

The length  $L$  and resistance  $R$  are measured for each cylinder.

It can be shown that  $R = \frac{\rho L^2}{5.83 \times 10^{-5}}$  where  $\rho$  is the resistivity of the conductive putty.

The student plots the graph shown in **Figure 8**.

Determine  $\rho$ .

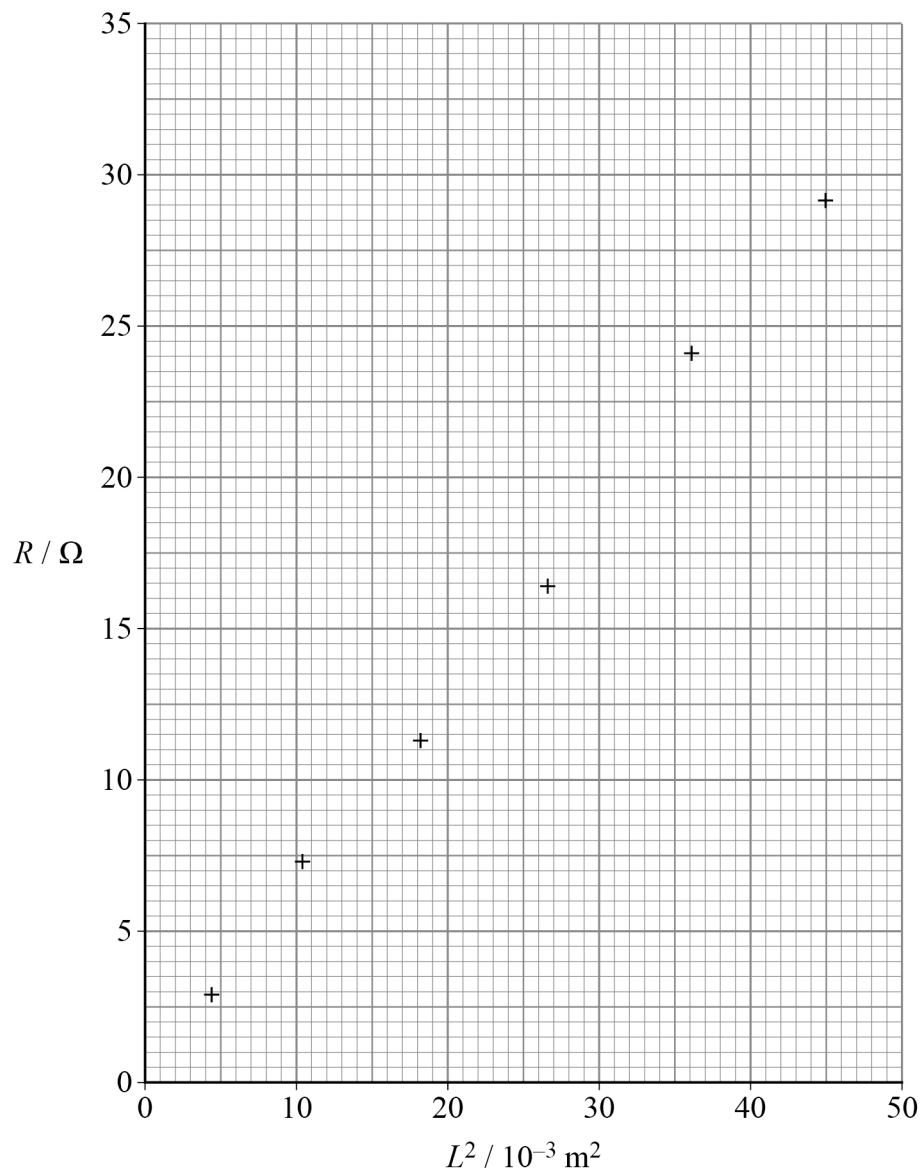
State an appropriate SI unit for your answer.

**[4 marks]**

$\rho =$  \_\_\_\_\_ unit = \_\_\_\_\_



Figure 8



Turn over for the next question

Turn over ►



0 4

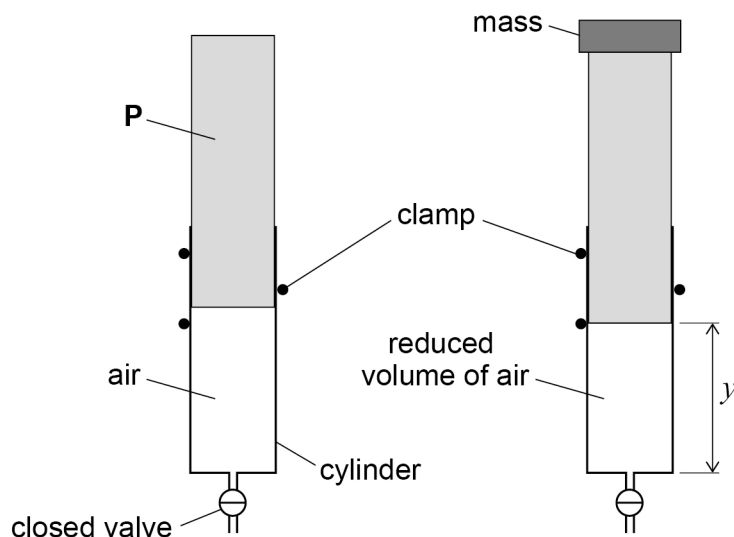
**Figure 9** shows air trapped in a vertical cylinder by a valve and a piston **P**. The valve remains closed throughout the experiment.

A mass is placed on top of **P**.

**P** moves downwards and the volume of the trapped air decreases.

There are no air leaks and there is no friction between the cylinder and **P**.

**Figure 9**



The vertical distance  $y$  between the end of **P** and the closed end of the cylinder is measured.

Additional masses are used to find out how  $y$  depends on the total mass  $M$  placed on top of **P**.

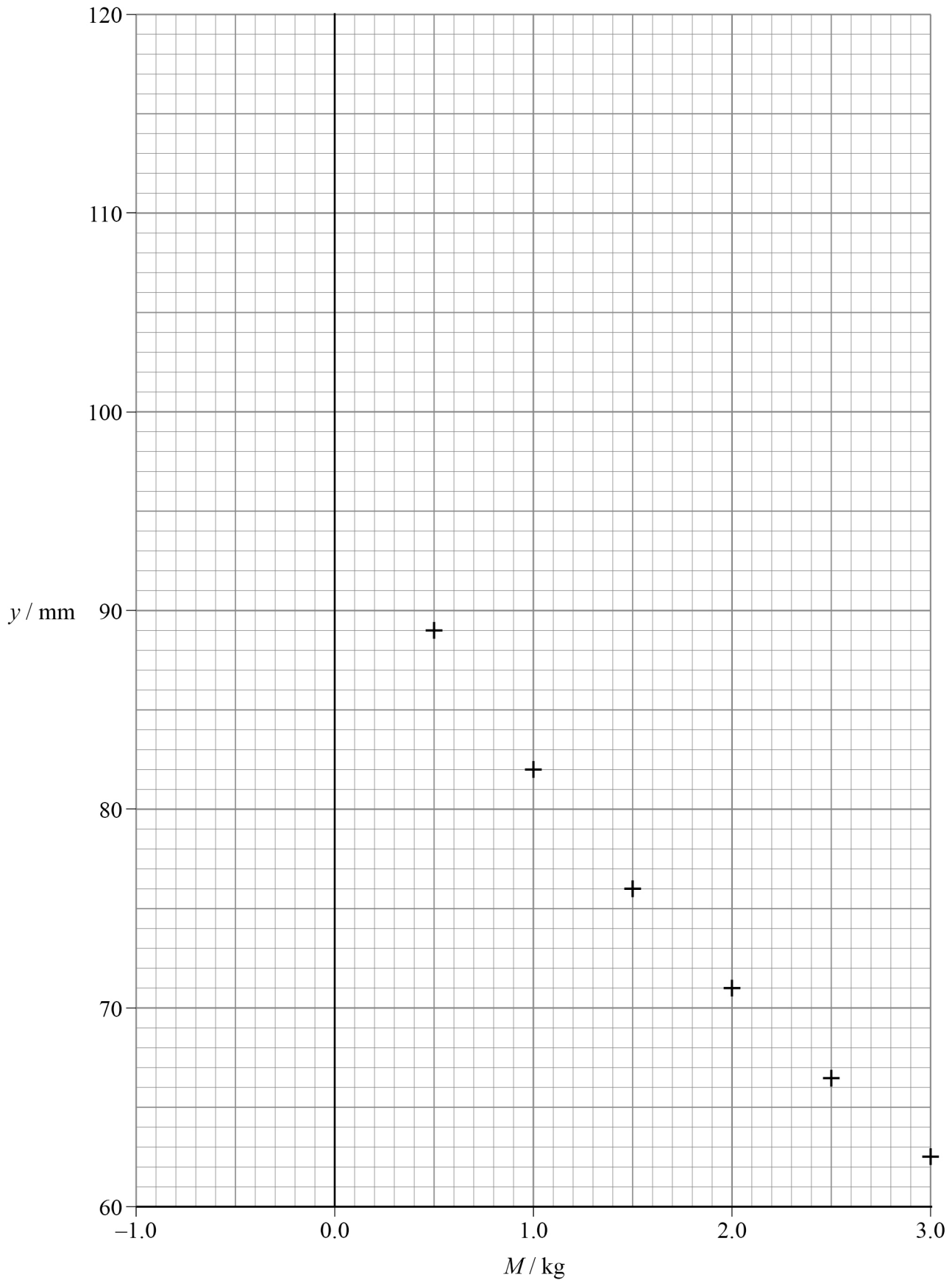
**Figure 10** shows a graph of these data.

0 4 . 1

Show that  $y$  is **not** inversely proportional to  $M$ .  
Use data points from **Figure 10**.

[2 marks]



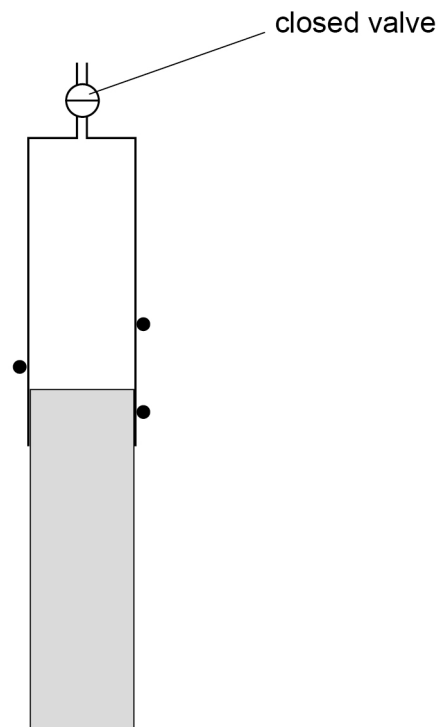
**Figure 10****Question 4 continues on the next page****Turn over ►**

0 4 . 2

The masses are removed and the cylinder is inverted.

**P** moves downwards without friction before coming to rest, as shown in **Figure 11**.

**Figure 11**



Explain why **P** does not fall out of the cylinder unless the valve is opened.

**[3 marks]**

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The mass of **P** is 0.350 kg.

Deduce  $y$  when the cylinder is in the inverted position shown in **Figure 11**.

Draw a line of best fit on **Figure 10** to arrive at your answer.

**[4 marks]**

$y =$  \_\_\_\_\_ mm

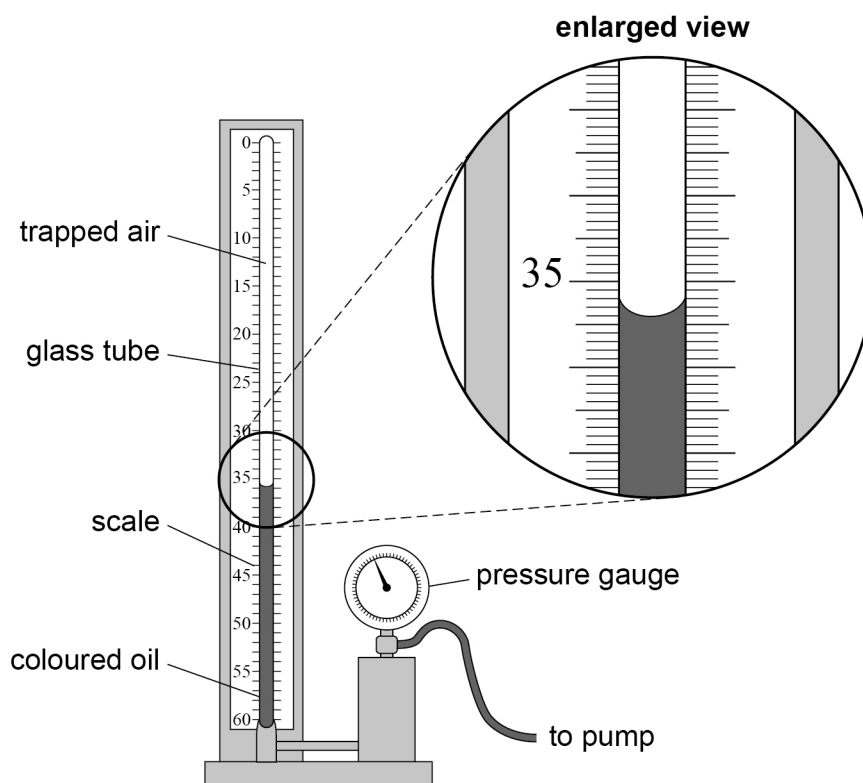
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**Figure 12** shows apparatus used in schools to investigate Boyle's law.

**Figure 12**



A fixed mass of air is trapped above some coloured oil inside a glass tube, closed at the top.

A pump applies pressure to the oil and the air.

The trapped air is compressed and its pressure  $p$  is read from the pressure gauge.



0 4 . 4

A scale, marked in  $0.2 \text{ cm}^3$  intervals, is used to measure the volume  $V$  of the air. A student says that the reading for  $V$  shown in **Figure 12** is  $35.4 \text{ cm}^3$ .

State:

- the error the student has made
- the correct reading, in  $\text{cm}^3$ , of the volume.

[2 marks]

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volume = \_\_\_\_\_  $\text{cm}^3$

**Question 4 continues on the next page**

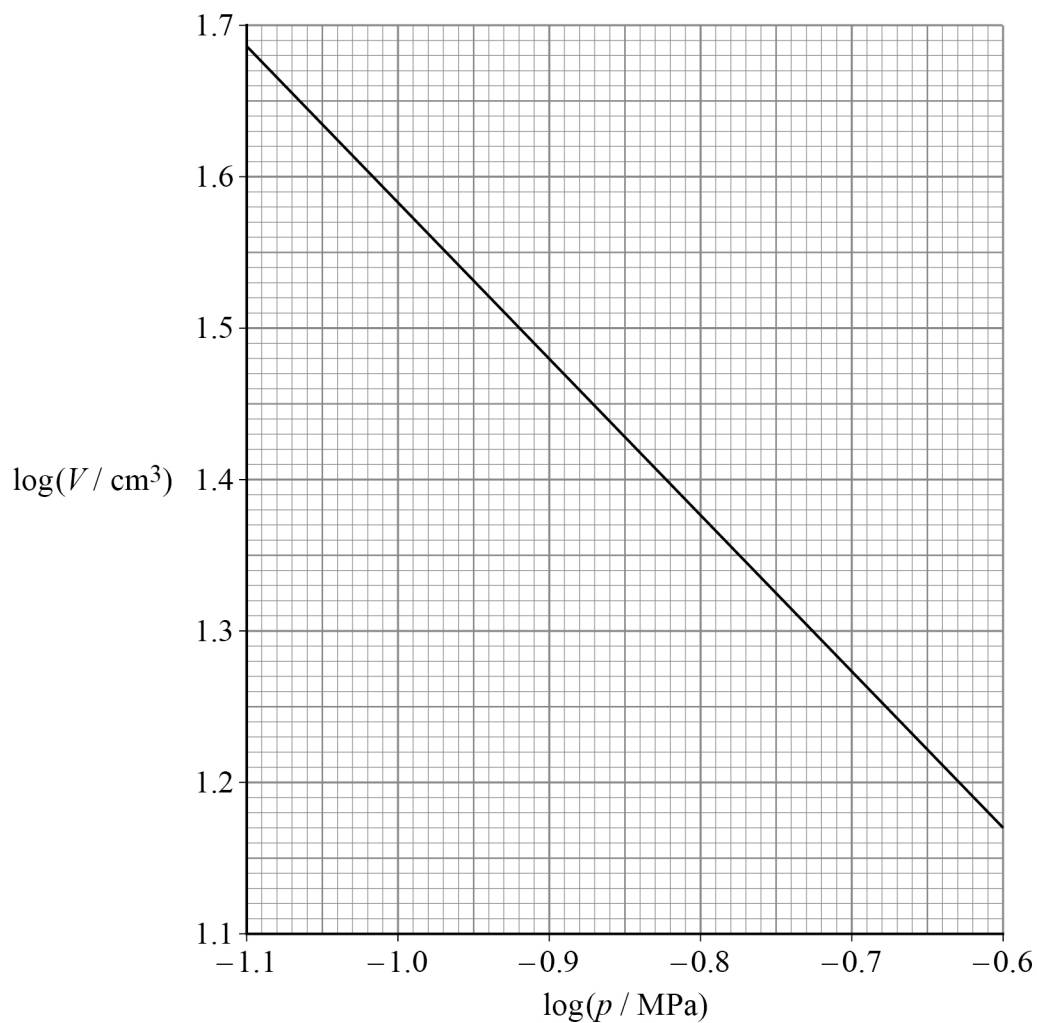
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0 4 . 5

Figure 13 shows data obtained using the apparatus in Figure 12.

Figure 13



Explain why the gradient of the graph in **Figure 13** confirms that the air obeys Boyle's law.

[3 marks]

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0 4 . 6

The largest pressure that can be read from the pressure gauge is  $3.4 \times 10^5$  Pa.

Determine, using **Figure 13**, the volume  $V$  corresponding to this pressure.

[3 marks]

$V =$  \_\_\_\_\_  $\text{cm}^3$

0 4 . 7

State **one** property of the air that must not change during the experiment.  
Go on to suggest how this can be achieved.

[2 marks]

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END OF QUESTIONS



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| Question<br>number | <p align="center"><b>Additional page, if required.</b></p> <p align="center"><b>Write the question numbers in the left-hand margin.</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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