A

AQA

Surname ______________________________

Other Names ______________________________

Centre Number ______________________________

Candidate Number ______________________________

Candidate Signature ______________________________

I declare this is my own work.

A-level

PHYSICS

Paper 3

Section A

7408/3A

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

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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.

For this paper you must have:
- **a pencil and a ruler**
- **a scientific calculator**
- **a Data and Formulae Booklet**
- **a Diagram Booklet**
- **a protractor.**

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**

[Turn over]

- **You must answer the questions in the spaces provided. Do not write 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 and a Diagram Booklet are provided as loose inserts.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

SECTION A

Answer ALL questions in this section.

0 1

FIGURE 1 is shown on page 2 of the Diagram Booklet.

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

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 is shown on page 3 of the Diagram Booklet.

FIGURE 2 shows the waveform then displayed on the oscilloscope.

0 1 . 1

Which control on the oscilloscope should be used to centre the trace vertically on the screen? [1 mark]

Tick (✓) ONE box.

- [ ] **X-shift**
- [ ] **Y-gain**
- [ ] **Y-shift**

[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 is shown on page 4 of the Diagram Booklet.

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 4 is shown on page 5 of the Diagram Booklet.

FIGURE 4 shows the time-base setting of the oscilloscope.

0 1 . 2

The distance between L and R in FIGURE 1 is 0.870 m.

Deduce the speed of sound in the steel rod. [3 marks]

speed of sound = ________________ $m\ s^{-1}$

[Turn over]

0 1 . 3

A student repeats the experiment using a steel rod of twice the length.

Explain:

- how using the longer rod affects the waveform displayed
- any changes needed to get an accurate result for the speed.

You should include numerical detail.
[4 marks]

8

[Turn over]

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0 2

FIGURE 5 is shown on page 6 of the Diagram Booklet.

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.

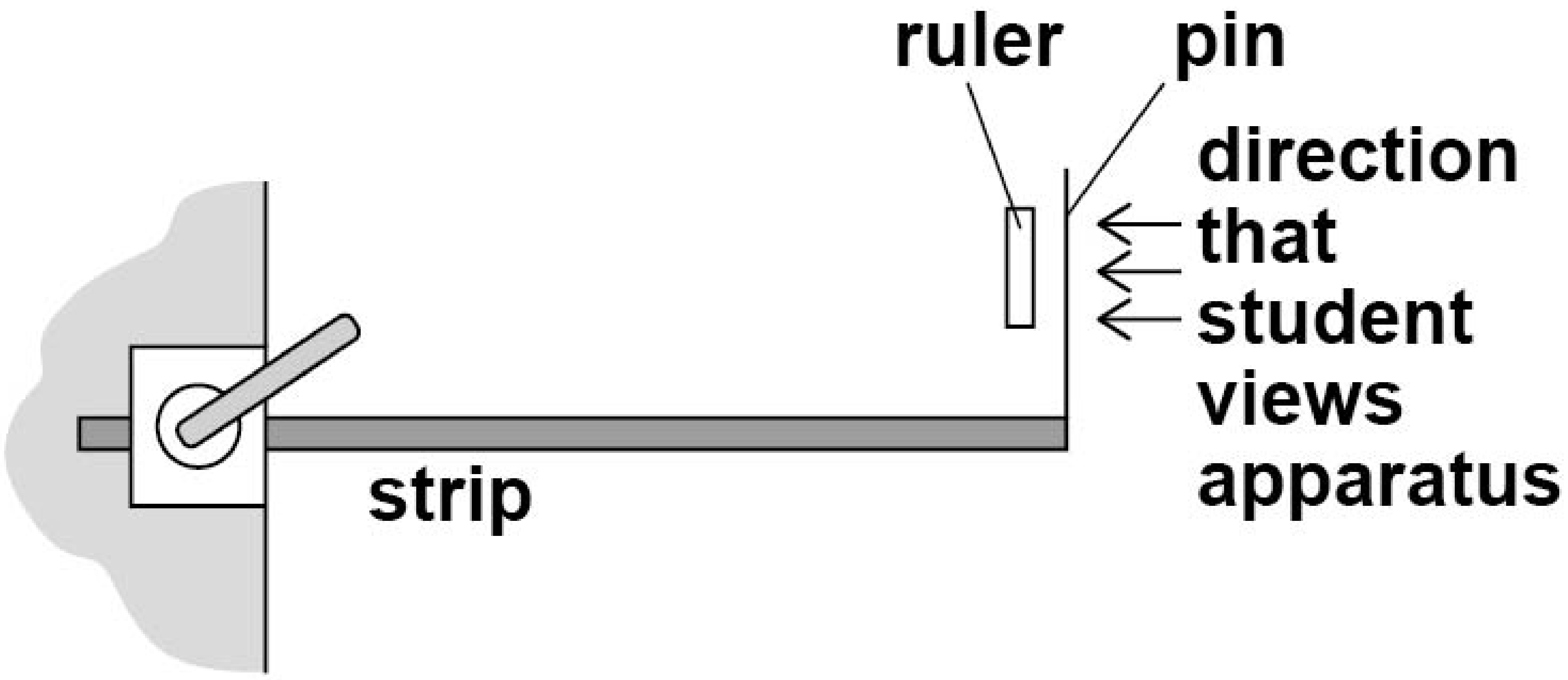
0 2 . 1

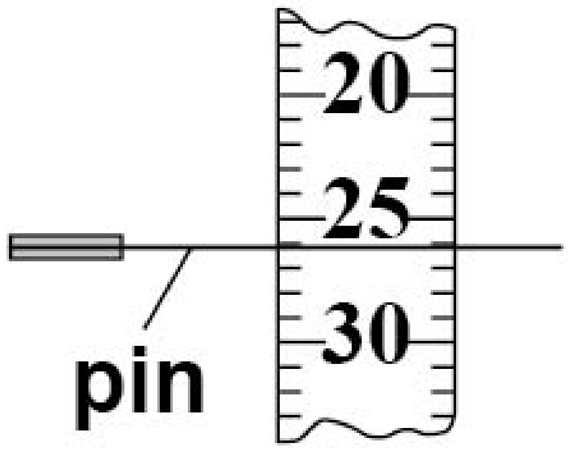
A mass m is suspended from the free end of the strip.
This produces a vertical displacement y.
A student intends to measure y with the aid of a horizontal pin fixed to the free end of the steel strip.
She positions a clamped vertical ruler behind the pin, as shown in FIGURE 6, on page 14.

[Turn over]

FIGURE 6

PLAN VIEW





VIEW SEEN BY STUDENT

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]

[Turn over]

0 2 . 2

It can be shown that

$$y = \frac{4mgL^3}{Ewt^3}$$

where:

L **is the distance between the free end of the UNLOADED strip and the blocks**

w **is the width of the strip and is approximately** $1\ \text{cm}$

t **is the thickness of the strip and is approximately** $1\ \text{mm}$

E **is the Young modulus of the steel.**

A student is asked to determine E **using the arrangement shown in FIGURE 5 with the following restrictions:**

- **only one steel strip of approximate length** $30\ \text{cm}$ **is available**

- m must be made using a 50 g mass hanger and up to four additional 50 g slotted masses
- the experimental procedure must involve only ONE independent variable
- a graphical method must be used to get the result for E.

Explain what the student must do to determine E. [5 marks]

7

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]

03.2

TABLE 1 shows the calliper measurements made by a student.

TABLE 1

d_1 / mm	d_2 / mm	d_3 / mm	d_4 / mm	d_5 / 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]

03.3

The length of the cylinder is 71 ± 2 mm.

Determine the uncertainty, in mm^3, in the volume of the cylinder. [4 marks]

uncertainty = ____________________ mm^3

[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 is shown on pages 8 and 9 of the Diagram Booklet.

FIGURE 7 shows the apparatus.

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

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

It can be shown that $R = \dfrac{\rho L^2}{5.83 \times 10^{-5}}$

where ρ is the resistivity of the conductive putty.

The student plots the graph shown in FIGURE 8 which is shown on page 10 of the Diagram Booklet.

Determine ρ.
State an appropriate SI unit for your answer. [4 marks]

ρ = ________________ **unit** = ________________

BLANK PAGE

0 4

FIGURE 9 is shown on page 12 of the Diagram Booklet.

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.

[Turn over]

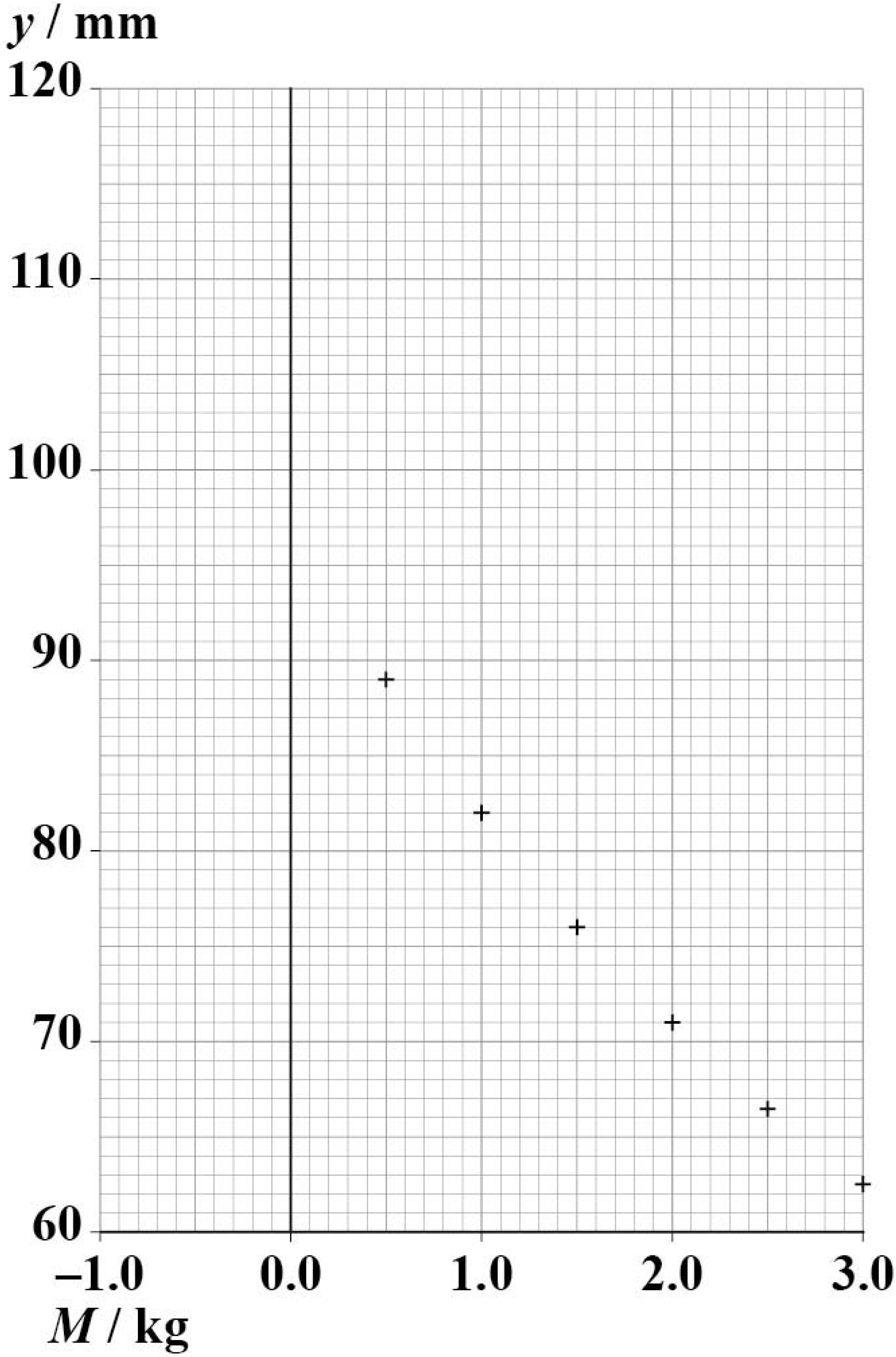
The vertical distance y between the end of P and the closed end of the cylinder is measured.
Additional masses are used to find out how y depends on the total mass M placed on top of P.

FIGURE 10, on the opposite page, 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



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, on page 13 of the Diagram Booklet.**

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

0 4 . 3

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, on page 29 of this Question Paper, to arrive at your answer. [4 marks]

$y =$ ____________________ mm

FIGURE 12 is shown on pages 14 and 15 of the Diagram Booklet.

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

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

State:

- **the error the student has made**
- **the correct reading, in cm^3, of the volume.**

[2 marks]

volume = ______________________ cm^3

[Turn over]

0 4 . 5

FIGURE 13 is shown on page 16 of the Diagram Booklet.

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

Explain why the gradient of the graph in FIGURE 13 confirms that the air obeys Boyle's law. [3 marks]

04.6

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

Determine, using FIGURE 13, the volume V corresponding to this pressure.
[3 marks]

$V =$ ______________________________ cm^3

[Turn over]

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]

END OF QUESTIONS

19

Additional page, if required.
Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
1	
2	
3	
4	
TOTAL	