

Please write clearly in	n block capitals.
Centre number	Candidate number
Surname	
Forename(s)	
Candidate signature	I declare this is my own work.

A-level PHYSICS

Paper 3 Section A

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.

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.

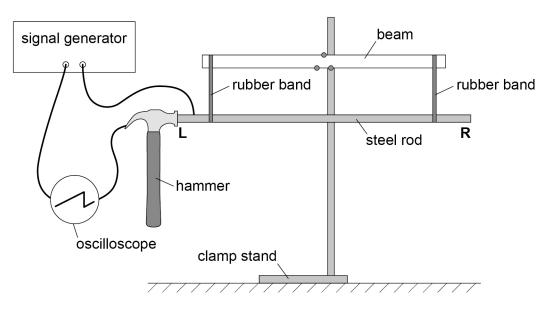
For Exam	iner's Use
Question	Mark
1	
2	
3	
4	
TOTAL	

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

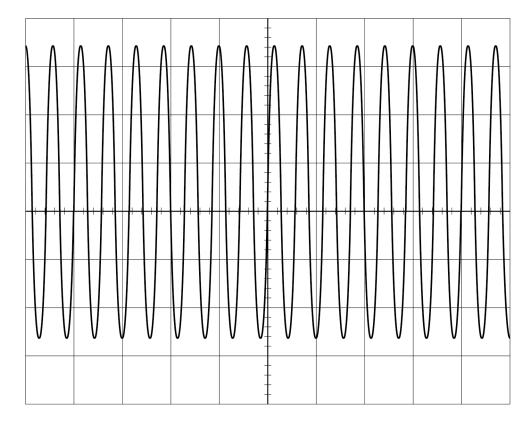


The steel rod is suspended from a beam using rubber bands. When the hammer is in contact with the end $\bf L$ of the steel rod, a circuit is completed and the signal generator is connected to the oscilloscope.

Figure 2 shows the waveform then displayed on the oscilloscope.







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



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

When the wave returns to ${\bf L}$ 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

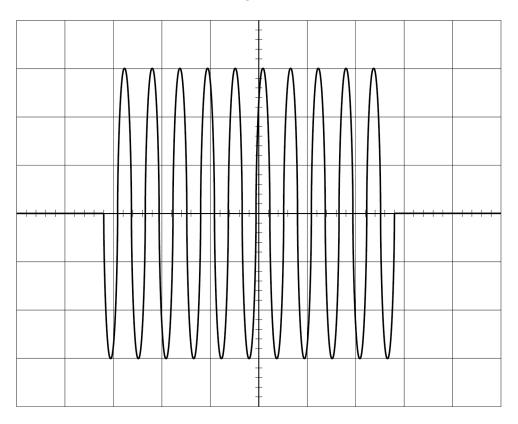


Figure 4 shows the time-base setting of the oscilloscope.

S

Figure 4

time / div



0 1 . 2	The distance between ${\bf L}$ and ${\bf R}$ in Figure 1 is $0.870~m$.	
	Deduce the speed of sound in the steel rod.	[3 marks]
	speed of sound =	m s ⁻¹
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]

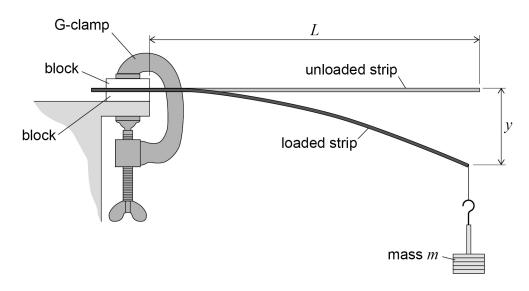




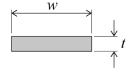
0 2

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
	ruler pin direction that student views apparatus
	strip
vie	pin 30
	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]
	Question 2 continues on the next page



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 cm t is the thickness of the strip and is approximately 1 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 cm is available
- \bullet $\it m$ must be made using a $50~\rm g$ mass hanger and up to four additional $50~\rm g$ 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]



Turn over for the next question



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

 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]
- 0 3.2 Table 1 shows the calliper measurements made by a student.

Table 1

d_1 / mm	d_2 / mm	<i>d</i> ₃ / mm	<i>d</i> ₄ / mm	<i>d</i> 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]



0 3.3	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
	Question 3 continues on the next page	



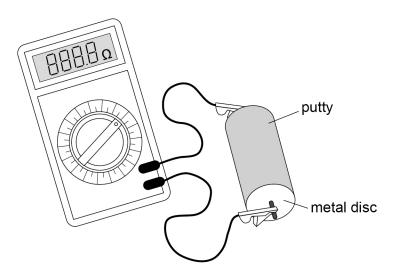
0 3 . 4

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 $5.83 \times 10^{-5} \ m^3$.

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 ρ is the resistivity of the conductive putty.

The student plots the graph shown in Figure 8.

Determine ρ .

State an appropriate SI unit for your answer.

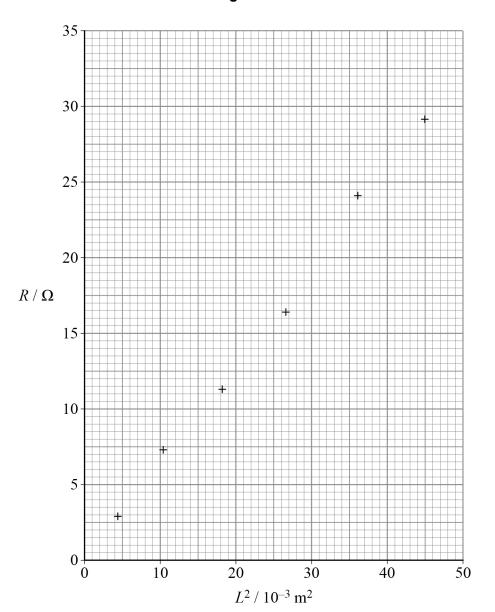
[4 marks]

$\rho =$	unit =	



Do not write outside the





11

Turn over for the next question





0 4

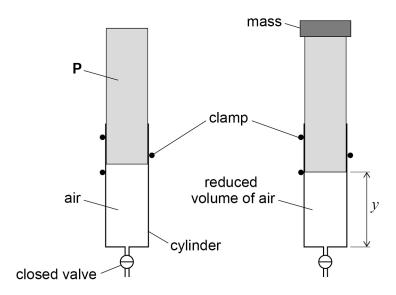
Figure 9 shows air trapped in a vertical cylinder by a valve and a piston **P**. The valve remains closed throughout the experiment.

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 ${\bf P}$.

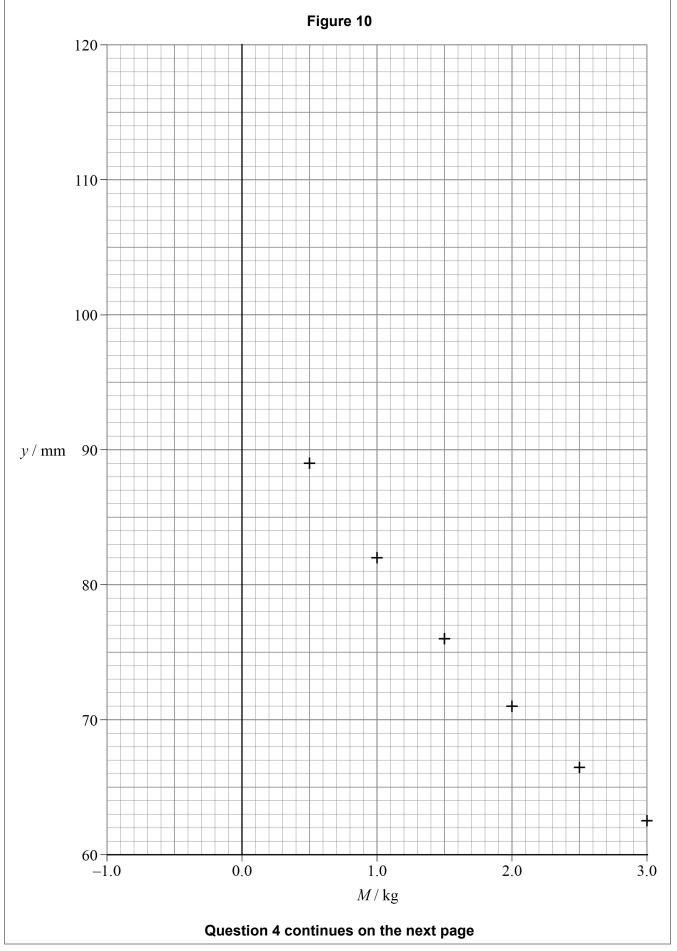
Figure 10 shows a graph of these data.

 $oxed{0}$ $oxed{4}$. Show that y is **not** inversely proportional to M. Use data points from **Figure 10**.

[2 marks]



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	16
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
	closed valve
	Explain why P does not fall out of the cylinder unless the valve is opened. [3 marks]

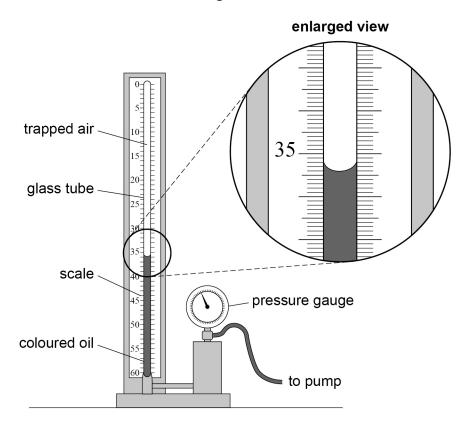


0 4.3	The mass of ${\bf P}$ is $0.350~kg$.	
	Deduce y when the cylinder is in the inverted position shown in Figure 11 .	
	Draw a line of best fit on Figure 10 to arrive at your answer.	[4 marks]
		[4 marks]
	y =	mm
	Question 4 continues on the next page	



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.



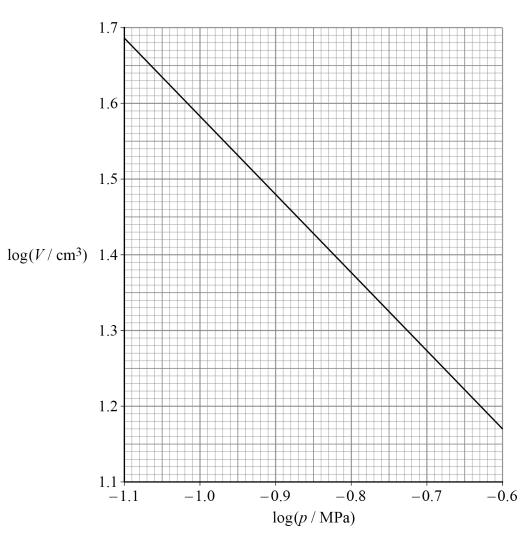
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0 4 . 4	A scale, marked in 0.2 cm^3 intervals, is used to measure the volume V of the air. A student says that the reading for V shown in Figure 12 is 35.4 cm^3 .			
	State:			
	 the error the student has made the correct reading, in cm³, of the volume. 	[2 marks]		
	volume =	cm ³		

Question 4 continues on the next page

0 4.5 Figure 13 shows data obtained using the apparatus in Figure 12.





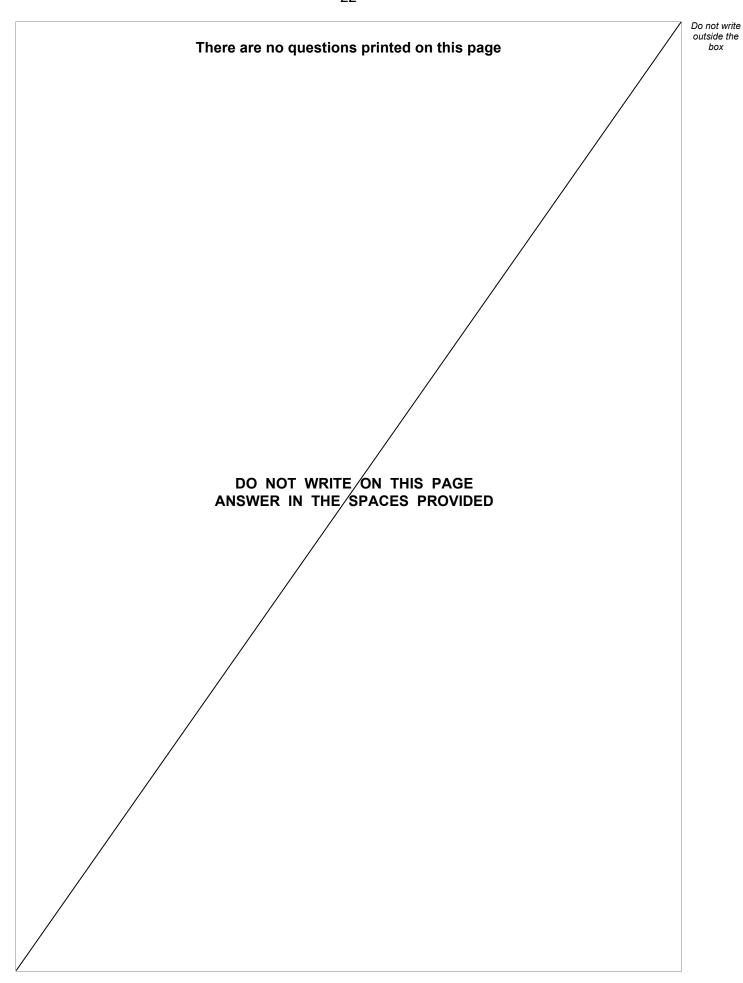
Explain why the gradient of the graph in **Figure 13** confirms that the air obeys Boyle's law.

[3 marks]



			Do n
4 . 6	The largest pressure that can be read from the pressure gauge is 3.4×10^5	Pa.	outs L
	Determine, using Figure 13 , the volume ${\it V}$ corresponding to this pressure.	[3 marks]	
		[o manno]	
	77	3	
	$V = \underline{\hspace{1cm}}$	cm ³	
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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