# OXFORDAQA

INTERNATIONAL QUALIFICATIONS

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

# INTERNATIONAL A-LEVEL PHYSICS

Unit 5 Physics in practice

Thursday 18 January 2024

07:00 GMT

### Time allowed: 2 hours

#### Materials

For this paper you must have:

- a Data and Formulae Booklet as a loose insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate
- 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.
- All working must be shown.
- 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.

#### Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.







Answer all questions in this section.
1.1       Describe how to reduce the effect of random errors on a set of measurements.       [1 mark         A student measures the length l of a simple pendulum six times using a metre ruler.         Table 1 shows her measurements.         Table 1         1/cm       89.4       89.3       89.5       89.4       89.5         1.2       Calculate the mean value of l.       [1 mark
A student measures the length $l$ of a simple pendulum six times using a metre ruler. <b>Table 1</b> shows her measurements. <b>Table 1</b> 1/cm 89.4 89.3 89.5 89.4 89.4 89.5 1.2 Calculate the mean value of $l$ . [1 mark
Table 1         1/cm       89.4       89.3       89.5       89.4       89.5         1.2       Calculate the mean value of <i>l</i> .       [1 mark]
<i>l</i> / cm       89.4       89.3       89.5       89.4       89.4       89.5         1.2       Calculate the mean value of <i>l</i> .       [1 mark]
1.2 Calculate the mean value of <i>l</i> . [1 mark
mean value of $l = $ cm
The student makes repeated measurements of the time for ten oscillations of the simple pendulum. She calculates that the mean period for one oscillation is $1.95~\rm s\pm1\%$ .
<b>1</b> . <b>3</b> Comment on whether the student's measurements of time are precise. <b>[1 mark</b>



	The student uses her measurements to determine a value for $g$ .	Do not write outside the box
0 1.4	Deduce whether the student's measurements are accurate. [2 marks]	
0 1 . 5	The percentage uncertainty in $l$ is 0.1%.	
	Another student suggests that there is a systematic error in some of the data.	
	Discuss the evidence for this suggestion. [1 mark]	
		6
	Turn over for the next question	
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0 2 . 1	State two reasons why student $A$ 's determination of $C$ has a greater percentation	age <sup>b</sup>	OX
	uncertainty than student <b>B</b> 's determination of <i>C</i> .	2 marks]	
	1		
	2		
0 2 2 2	Deduce, by considering uncertainties, whether the data suggest that both stu	dents	
		5 marks]	
		-	
			_
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0 3	<b>Figure 2</b> shows apparatus used to determine the number of lines per millimetre on a plane transmission diffraction grating. The laser emits light of wavelength 633 nm.	box
	Figure 2	
	diffraction grating screen	
	laser	
	Describe an experiment to determine the number of lines per millimetre on the grating. Refer to the equipment in <b>Figure 2</b> and any other necessary equipment.	
	In your answer you should:	
	<ul> <li>state the measurements to be made and the steps taken to ensure that the measurements are taken safely</li> <li>describe how to process the results</li> </ul>	
	<ul> <li>describe how the experiment should be carried out to ensure accuracy.</li> <li>[6 marks]</li> </ul>	







**Table 3** shows values of l, I and  $I^{-1}$ .

Table	3
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<i>l</i> / m	<i>I /</i> A	$I^{-1} / \mathrm{A}^{-1}$
0.100	2.38	0.42
0.300	1.02	0.98
0.500	0.72	1.39
0.700	0.52	1.92
0.900	0.44	2.27
0.700	0.52 0.44	1.92 2.27

## 0 4 . 1

Draw, on **Figure 4**, a graph to show the variation of  $I^{-1}$  with *l*. Draw a best-fit line.

[4 marks]

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box







04.2	Determine the gradient of the graph that you have drawn in <b>Figure 4</b> . [2 marks]	Do not write outside the box
	R is the resistance of a length $l$ of the wire. The equation that relates $I$ to $R$ is:	
	$\frac{1}{I} = \frac{R}{\varepsilon} + \frac{r}{\varepsilon}$	
0 4 . 3	The resistance wire has a diameter of $0.457 \text{ mm}$ . Calculate, using your answer to Question <b>04.2</b> , the resistivity of the material in the	
	resistance wire. [3 marks]	
	resistivity = $\Omega$ m	
04.4	Calculate <i>r</i> using data from your graph in <b>Figure 4</b> . [2 marks]	
	<i>r</i> =Ω	11









where M is the mass of the star HD 108236.



0 5.1	Show that the intercept $c$ on a graph of $\ln(T / s)$ against $\ln(r / m)$ is given by:	Do not write outside the box
	$c = \frac{1}{2} \ln \left( \frac{4\pi^2}{GM} \right)$	
	[2 marks]	
0 5.2	Explain, without calculation, how the gradient of the graph in <b>Figure 5</b> can be used to show that the astronomers' data are consistent with the relationship on page 12. [1 mark]	
0 5.3	Determine <i>M</i> . [3 marks]	
	<i>M</i> =kg	6
	END OF SECTION A	
	Turn over ►	l





**P** and **Q** are masses each of mass M. They fall from rest from an initial height habove the ground. They are connected to a pulley system that turns sets of paddles. The paddles do work by stirring the water in the container.

The gravitational potential energies of **P** and **Q** are transferred to the water. The temperature of the water increases as a result of the work done as P and Q fall.

When **P** and **Q** reach the ground, the apparatus is reset as in **Figure 6** without causing the paddles to turn. **P** and **Q** are allowed to fall a total of 20 times.

The data collected are:

h = 1.5963 mM = 13.158 kgm = 6.2512 kg $\Delta \theta = 0.364 \text{ K}$ 

where  $\Delta \theta$  is the total increase in temperature of the water and *m* is the mass of the water.



box

06.1	The initial temperature of the water in the container is lower than the temperature of the surroundings.
	Explain, with reference to the first law of thermodynamics, why the temperature of the water increases during this experiment.
	[3 marks]
06.2	Show that the total energy transferred by <b>P</b> and <b>Q</b> as they fall is approximately 8240 J. [2 marks]
0 6 . 3	State and explain the appropriate number of significant figures that should be given in the answer to Question <b>06.2</b> . [1 mark]
	Question 6 continues on the next page



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Turn over ►

	After each release, <b>P</b> and <b>Q</b> accelerate briefly before falling at a constant speed of $6.15 \text{ cm s}^{-1}$ until they hit the ground.
06.4	Explain, in terms of the forces acting on the paddles, why <b>P</b> and <b>Q</b> accelerate briefly before falling at constant speed.
06.5	Calculate the total kinetic energy of <b>P</b> and <b>Q</b> before they hit the ground. [1 mark]
	total kinetic energy =
	Eveloin whether the work done on the water by <b>R</b> and <b>O</b> is significantly effected by the
	total kinetic energy of <b>P</b> and <b>Q</b> . [2 marks]



Do not write outside the box 0 6.7 The total energy transferred by **P** and **Q** as they fall is approximately 8240 J.  $\Delta \theta = 0.364 \text{ K}$ m = 6.2512 kgJoule estimated that: 360 J was used to increase the temperature of the container and the paddles • 0.060 K of the total increase in temperature of the water was caused by thermal conduction from the surroundings. Calculate a value for the specific heat capacity of water. [3 marks]  $J \ kg^{-1} \ K^{-1}$ specific heat capacity = Question 6 continues on the next page



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Do not write outside the box **Figure 7** shows the diameters of the pulleys and the drum. The pulleys are frictionless. The container and the water have been omitted from **Figure 7**.

**P** and **Q** each has a mass *M* of 13.158 kg and produce tensions in their strings of  $T_{\rm P}$  and  $T_{\rm Q}$  respectively.





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**9** P and **Q** fall through height *h* a total of 20 times in 519 s. The total work done on the drum by  $T_1$  and  $T_2$  during this time is 8240 J.

Calculate the angular velocity of the drum.

angular velocity =

rad  $s^{-1}$ 

19

[2 marks]

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Turn over for the next question



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19

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0 7	<b>Figure 9</b> shows a capacitor <b>C</b> with wires attached to its two circular conducting plates <b>P</b> and <b>Q</b> . The plates are separated by an air gap of width $d$ .	outside the box
	Figure 9	
	$- \underbrace{P}_{Q}_{I}$	
	${\bf P}$ and ${\bf Q}$ each has a radius of $1.3~cm.$ The capacitance of ${\bf C}$ is $52~pF.$	
0 7.1	Show that <i>d</i> is approximately $9.0 \times 10^{-5}$ m. [2 marks]	







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	S remains closed and C becomes fully charged.	box
	<b>C</b> is now used as a microphone.	
	A sound wave of frequency $100~{\rm Hz}$ arrives at plate P. This causes P to oscillate while Q does not move.	
	<b>P</b> oscillates with simple harmonic motion at a frequency of $100 \text{ Hz}$ and with an amplitude of $4.5 \times 10^{-6} \text{ m}$ . The width of the air gap repeatedly increases and decreases.	
07.3	Explain why the charge on <b>C</b> stays approximately constant as <b>P</b> oscillates.	
	[2 marks]	
		-
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0 7.4	The width of the air gap decreases by $4.5\times 10^{-6}\ m$ compared with its value in Question <b>07.1</b> .	
	Deduce the effect of this change on $V$ .	
	[3 marks]	
		_
		_
		_
		_















<ul> <li>White light is emitted from the interior of the star. Atoms in the star's outer layers absorb photons of certain frequencies. This causes the dips in intensity in Figure 12. The atoms in the outer layers are excited when they absorb the photons.</li> <li>Explain why the photon frequencies at which the dips occur depend on the particular elements present in the outer layers of the star.</li> <li>[2 marks]</li> </ul>	Do not write outside the box
Antares is a star system that is 550 light years from the Earth. A light year is the distance travelled by light in one year. Antares emits $7.59 \times 10^4$ times as much energy per second as the Sun. Show that one light year is approximately equivalent to $9.5 \times 10^{15}$ m. [1 mark]	

 $I_{\rm A}$  is the intensity of light from Antares at the position of the Earth. 0 8 . 4  $I_{\rm S}$  is the intensity of light from the Sun at the position of the Earth.

Calculate  $\frac{I_{\rm A}}{I_{\rm S}}$ 

radius of the Earth's orbit around the Sun =  $1.5 \times 10^{11} \text{ m}$ 

[3 marks]



0 8 . 2

08.

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





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