

Write your name here

Surname	Other names
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**Pearson Edexcel**  
**International**  
**Advanced Level**

Centre Number	Candidate Number												
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# Physics

## Advanced

### Unit 6: Experimental Physics

Thursday 15 May 2014 – Morning <b>Time: 1 hour 20 minutes</b>	Paper Reference <b>WPH06/01</b>
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<b>You must have:</b> Ruler	Total Marks
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### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*

### Information

- The total mark for this paper is 40.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

### Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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**Answer ALL questions in the spaces provided.**

**1** (a) A student measures the diameter  $d$  of a thin resistance wire.

(i) State why a micrometer screw gauge is the most appropriate instrument to use to measure the diameter of the wire.

(1)

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(ii) State **one** technique the student should use to determine a value for the diameter of the wire, which is as accurate as possible.

(1)

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(b) The student also measures the length  $l$  and the resistance  $R$  of the wire. She records the following mean values.

$l/\text{cm}$	89.4
$d/\text{mm}$	$0.204 \pm 0.003$
$R/\Omega$	$15.68 \pm 0.07$

(i) Use these values to calculate the resistivity of the material of the wire in  $\Omega \text{ m}$ .

(2)

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Resistivity = .....  $\Omega \text{ m}$

(ii) Calculate the percentage uncertainty in your value for the resistivity. You may assume the uncertainty in the value for  $l$  is negligible.

(3)

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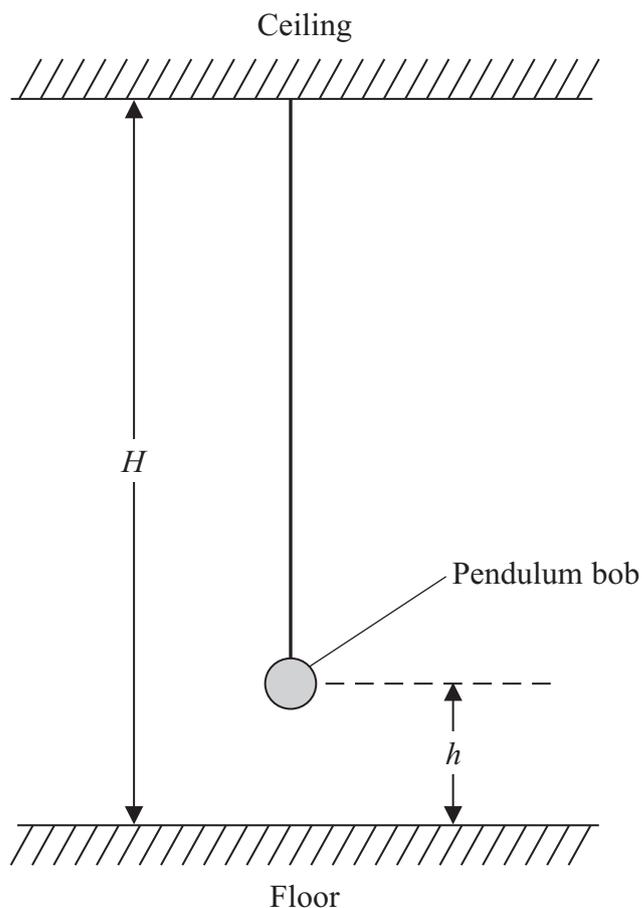
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Percentage uncertainty = .....

**(Total for Question 1 = 7 marks)**



- 2 A student has been asked to determine the height  $H$  of a ceiling, using a simple pendulum as shown below.



The student measures the distance  $h$  from the floor to the centre of the pendulum bob. He determines values of the time period  $T$  of the pendulum for different values of  $h$ .

- (a) Describe how he should use a metre rule to measure  $h$ .

You may add to the diagram if you wish.

(3)

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(b) Describe what the student should do to make his values for  $T$  as accurate as possible.

(3)

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(c) The relationship between  $T$  and  $h$  is given by

$$T^2 = \frac{4\pi^2 H}{g} - \frac{4\pi^2 h}{g}$$

Plotting  $T^2$  against  $h$  gives a straight line graph.

(i) State an expression for the gradient of the graph of  $T^2$  against  $h$ .

(1)

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(ii) Show that a value for  $H$  can be obtained from the expression

$$H = \frac{\text{intercept}}{\text{gradient}}$$

(2)

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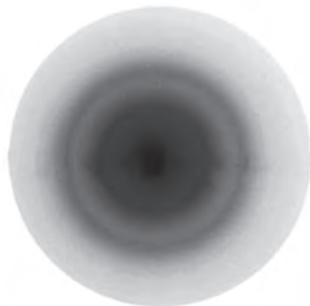
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**(Total for Question 2 = 9 marks)**



- 3 An experiment is set up to show the diffraction of electrons. A beam of electrons is accelerated by a potential difference  $V$  in a vacuum tube and passes through a thin foil target. The diffracted electrons produce a ring pattern as shown below.



By measuring the diameter of the rings it is possible to calculate a value for the wavelength  $\lambda$  of the electrons from

$$V = k \lambda^{-2}$$

where  $k$  is a constant.

The following data were recorded for two different values of  $V$ .

$V/\text{kV}$	$\lambda/10^{-12} \text{ m}$	
200	2.51	
300	1.95	

- (a) (i) Calculate a value for  $k$ . You may add to the table if you wish.

(3)

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$k =$  .....

- (ii) Estimate the percentage uncertainty in your value for  $k$ .

(1)

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.....

Percentage uncertainty = .....



(b) Theory suggests that

$$k = \frac{h^2}{2em_e}$$

where  $h$  is the Planck constant,  $e$  is the electron charge and  $m_e$  is the electron mass.

(i) Use your value for  $k$  to calculate a value for  $h$ . (2)

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$h =$  .....

(ii) Estimate the percentage uncertainty in your value for  $h$ . (1)

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Percentage uncertainty = .....

(iii) Comment on the validity of your answer for  $h$ . (2)

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**(Total for Question 3 = 9 marks)**



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(c) The resistance  $R$  of the thermistor is related to its temperature  $\theta$  by

$$R = R_0 e^{-\alpha\theta}$$

where  $R_0$  and  $\alpha$  are constants.

(i) Show that a graph of  $\ln R$  against  $\theta$  should be a straight line.

(1)

(ii) In an experiment to measure  $R$  and  $\theta$  the following data were recorded.

$\theta / ^\circ\text{C}$	$R / \text{k}\Omega$	
19	6.17	
30	4.35	
42	2.66	
50	1.96	
62	1.25	
70	0.906	

Use the grid opposite to draw a graph of  $\ln R$  against  $\theta$ . Use the column in the table for your processed data.

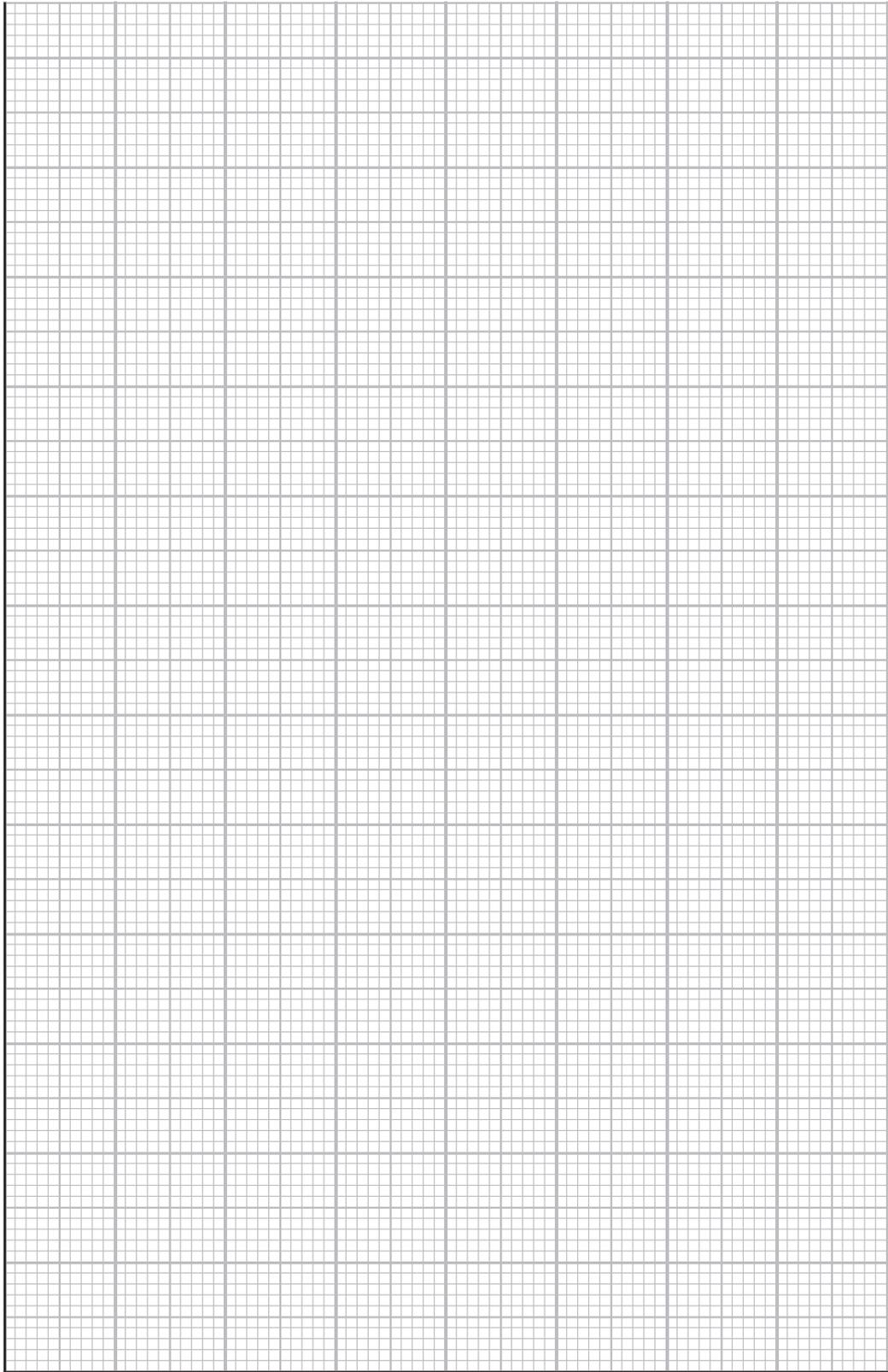
(4)

(iii) Use your graph to determine a value for  $\alpha$ .

(3)

$\alpha = \dots\dots\dots$





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**(Total for Question 4 = 15 marks)**

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**TOTAL FOR PAPER = 40 MARKS**



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**List of data, formulae and relationships**

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$	
Coulomb's law constant	$k = 1/4\pi\epsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
Electron charge	$e = -1.60 \times 10^{-19} \text{ C}$	
Electron mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$	
Electronvolt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	
Gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to Earth's surface)
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$	
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	
Proton mass	$m_p = 1.67 \times 10^{-27} \text{ kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27} \text{ kg}$	

**Unit 1***Mechanics*

Kinematic equations of motion	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
Forces	$\Sigma F = ma$ $g = F/m$ $W = mg$
Work and energy	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{\text{grav}} = mg\Delta h$

*Materials*

Stokes' law	$F = 6\pi\eta rv$
Hooke's law	$F = k\Delta x$
Density	$\rho = m/V$
Pressure	$p = F/A$
Young modulus	$E = \sigma/\epsilon$ where Stress $\sigma = F/A$ Strain $\epsilon = \Delta x/x$
Elastic strain energy	$E_{\text{el}} = \frac{1}{2}F\Delta x$



**Unit 2***Waves*

Wave speed	$v = f\lambda$
Refractive index	${}_1\mu_2 = \sin i / \sin r = v_1 / v_2$

*Electricity*

Potential difference	$V = W/Q$
Resistance	$R = V/I$
Electrical power, energy and efficiency	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VI t$

$$\% \text{ efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$$

$$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{total power input}} \times 100$$

Resistivity	$R = \rho l/A$
Current	$I = \Delta Q / \Delta t$ $I = nqvA$
Resistors in series	$R = R_1 + R_2 + R_3$
Resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

*Quantum physics*

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2}mv_{\max}^2$



**Unit 4***Mechanics*

Momentum	$p = mv$
Kinetic energy of a non-relativistic particle	$E_k = p^2/2m$
Motion in a circle	$v = \omega r$ $T = 2\pi/\omega$ $F = ma = mv^2/r$ $a = v^2/r$ $a = r\omega^2$

*Fields*

Coulomb's law	$F = kQ_1Q_2/r^2$ where $k = 1/4\pi\epsilon_0$
Electric field	$E = F/Q$ $E = kQ/r^2$ $E = V/d$
Capacitance	$C = Q/V$
Energy stored in capacitor	$W = \frac{1}{2}QV$
Capacitor discharge	$Q = Q_0 e^{-t/RC}$
In a magnetic field	$F = BIl \sin \theta$ $F = Bqv \sin \theta$ $r = p/BQ$
Faraday's and Lenz's Laws	$\epsilon = -d(N\phi)/dt$

*Particle physics*

Mass-energy	$\Delta E = c^2 \Delta m$
de Broglie wavelength	$\lambda = h/p$



**Unit 5***Energy and matter*

Heating  $\Delta E = mc\Delta\theta$

Molecular kinetic theory  $\frac{1}{2}m\langle c^2 \rangle = \frac{3}{2}kT$

Ideal gas equation  $pV = NkT$

*Nuclear Physics*

Radioactive decay  $dN/dt = -\lambda N$

$$\lambda = \ln 2/t_{1/2}$$

$$N = N_0 e^{-\lambda t}$$

*Mechanics*

Simple harmonic motion

$$a = -\omega^2 x$$

$$a = -A\omega^2 \cos \omega t$$

$$v = -A\omega \sin \omega t$$

$$x = A \cos \omega t$$

$$T = 1/f = 2\pi/\omega$$

Gravitational force  $F = Gm_1m_2/r^2$

*Observing the universe*

Radiant energy flux  $F = L/4\pi d^2$

Stefan-Boltzmann law

$$L = \sigma T^4 A$$

$$L = 4\pi r^2 \sigma T^4$$

Wien's Law  $\lambda_{\max} T = 2.898 \times 10^{-3} \text{ m K}$

Redshift of electromagnetic radiation  $z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$

Cosmological expansion  $v = H_0 d$

