Write your name here

Surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number

Candidate Number

Physics

Advanced
Unit 6: Experimental Physics

Thursday 15 May 2014 – Morning
Time: 1 hour 20 minutes

Paper Reference
WPH06/01

You must have:
Ruler

Total Marks

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 ▶

PEARSON

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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*/cm**	89.4
***d*/mm**	0.204 ± 0.003
***R*/Ω**	15.68 ± 0.07

(i) Use these values to calculate the resistivity of the material of the wire in Ω m.

(2)

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Resistivity = ... Ω 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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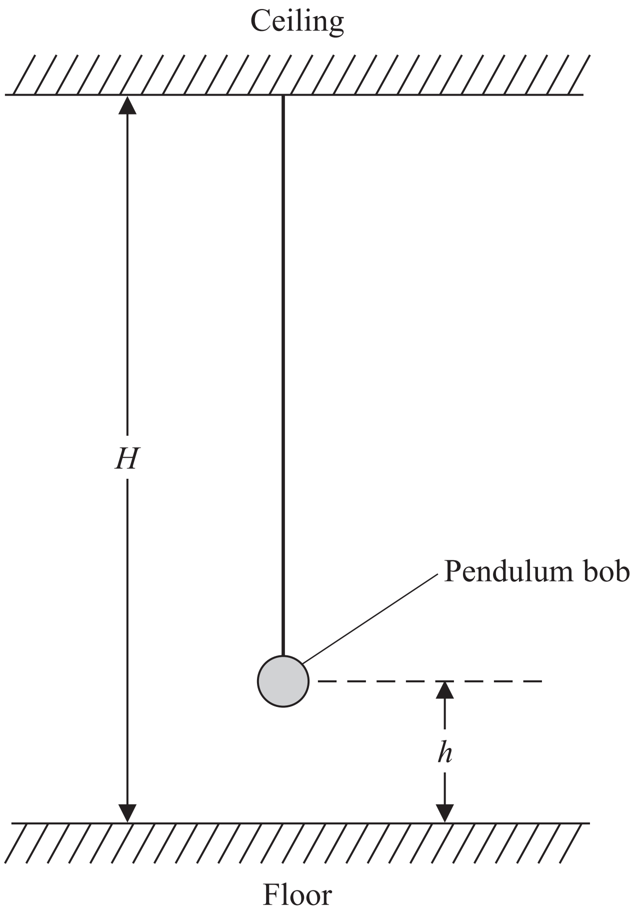
Percentage uncertainty = ...

(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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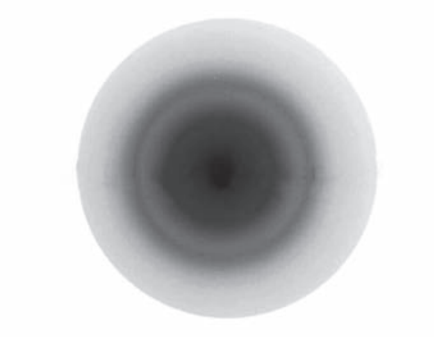
(Total for Question 2 = 9 marks)

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

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

(3)

....

....

....

....

....

k = ...

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

(1)

....

....

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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4 (a) Explain why the resistance of a thermistor decreases as its temperature increases.

(2)

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(b) Plan an experiment to determine how the resistance of a thermistor changes as its temperature is increased from 0 °C to 100 °C.

Your plan should include:

(i) the apparatus required, **(2)**

(ii) how you would obtain the temperature range, **(1)**

(iii) the precautions you would take to ensure accurate measurements. **(2)**

You may draw a diagram if you wish.

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(c) The resistance R of the thermistor is related to its temperature θ by

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

where R_0 and α are constants.

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

(1)

....

....

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

$\boldsymbol{\theta}$ **/ °C**	$\boldsymbol{R}$ **/ kΩ**	
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 θ. Use the column in the table for your processed data.

(4)

(iii) Use your graph to determine a value for α.

(3)

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α = ...

(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 40 MARKS

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List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \mathrm{m\ s^{-2}}$	(close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23}\ \mathrm{J\ K^{-1}}$	
Coulomb's law constant	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^{9}\ \mathrm{N\ m^2\ C^{-2}}$	
Electron charge	$e = -1.60 \times 10^{-19}\ \mathrm{C}$	
Electron mass	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$	
Electronvolt	$1\ \mathrm{eV} = 1.60 \times 10^{-19}\ \mathrm{J}$	
Gravitational constant	$G = 6.67 \times 10^{-11}\ \mathrm{N\ m^2\ kg^{-2}}$	
Gravitational field strength	$g = 9.81\ \mathrm{N\ kg^{-1}}$	(close to Earth's surface)
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\ m^{-1}}$	
Planck constant	$h = 6.63 \times 10^{-34}\ \mathrm{J\ s}$	
Proton mass	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \mathrm{m\ s^{-1}}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\ \mathrm{W\ m^{-2}\ K^{-4}}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$	

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	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{grav} = mg\Delta h$

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	$E = \sigma/\varepsilon$ where Stress $\sigma = F/A$ Strain $\varepsilon = \Delta x/x$
Elastic strain energy	$E_{el} = \frac{1}{2}F\Delta x$

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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\% \text{ efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100$
	$\% \text{ efficiency} = \dfrac{\text{useful power output}}{\text{total power input}} \times 100$
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	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

Quantum physics

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

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 $k = 1/4\pi\varepsilon_0$
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	$\varepsilon = -\mathrm{d}(N\phi)/\mathrm{d}t$

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	$\tfrac{1}{2}m\langle c^2\rangle = \tfrac{3}{2}kT$
Ideal gas equation	$pV = NkT$

Nuclear Physics

Radioactive decay	$\mathrm{d}N/\mathrm{d}t = -\lambda N$
	$\lambda = \ln 2/t_{1/2}$
	$N = N_0 \mathrm{e}^{-\lambda t}$

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	$\lambda_{max}T = 2.898 \times 10^{-3}$ m K
Redshift of electromagnetic radiation	$z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$
Cosmological expansion	$v = H_0 d$