Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Physics

Advanced
Unit 6: Experimental Physics

Thursday 14 May 2015 – Afternoon
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 ▶

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Answer ALL questions in the spaces provided.

1 A student was asked to determine the density of the metal from which a food can is made.



(a) She calculated the volume of the metal by determining the external volume of the can and subtracting the internal volume.

(i) She measured the external height of the can using a metre rule.

State the precision of a metre rule.

(1)

.....

(ii) She used two set squares and a metre rule to measure the external diameter of the can.

Describe how you would use this apparatus to measure accurately the diameter of a can. Your description should include a diagram.

(2)

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(b) The student recorded the following results.

Quantity	Measurements	Mean value
Internal volume / cm^3	391 399 398	396
Height / cm	10.1 10.1 10.1	10.1
External diameter / cm	7.2 7.1 7.3	7.2
Mass / kg	4.982×10^{-2}	

The volume of a cylinder is given by $V = \pi r^2 h$

where r is the radius of the cylinder and h is its height.

(i) Use these measurements to show that the external volume is about 400 cm^3.

(1)

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.....

(ii) Hence calculate a value for the volume of the metal.

(1)

.....

Volume of metal = ...

(iii) Hence calculate a value for the density of the metal.

(2)

.....

.....

Density of metal = ...

(c) (i) Use the measurements to estimate the percentage uncertainty in the external volume. You should assume the uncertainty in the height measurement is negligible.

(2)

.....

.....

.....

.....

Percentage uncertainty = ... %

(ii) Use the measurements to estimate the percentage uncertainty in the internal volume.

(1)

.....

.....

Percentage uncertainty = ... %

(iii) The volume of metal was determined by subtracting the internal volume of the can from the external volume. This produces a percentage uncertainty for the volume of metal which is greater than 10%.

Suggest why.

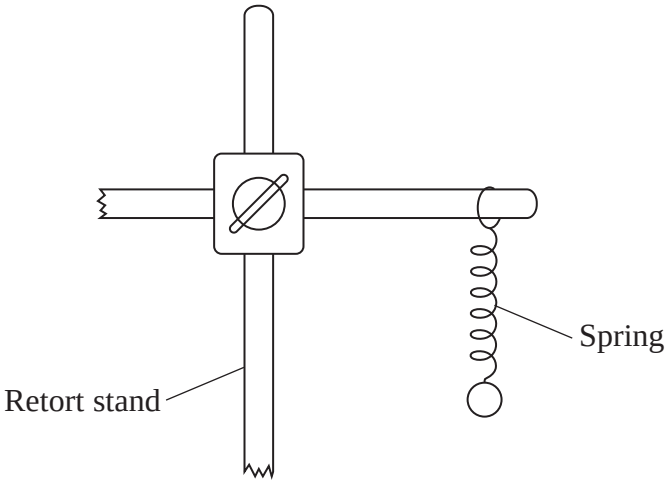
(1)

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(Total for Question 1 = 11 marks)

2 A student is asked to determine the spring constant for a small spring.



He has the following additional apparatus:

50 g mass hanger with 9 × 50 g masses

stopwatch with a precision of 0.01 s

optical pin.

He is told that the time period T for vertical oscillations of a mass m is

$$T = 2\pi\sqrt{\frac{m}{k}}$$

where k is the spring constant.

The student decides to determine the period of oscillation for different values of mass.

(a) (i) Describe how he could make his readings for the time period as accurate as possible.

(2)

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.....

(ii) Describe the graph he should plot to obtain a straight line and how to determine the spring constant from the graph.

(3)

(b) His teacher suggests using a position sensor with a datalogger instead of the stopwatch.

(i) Draw a diagram to show how this apparatus could be used to record the position of the hanging mass.

(2)

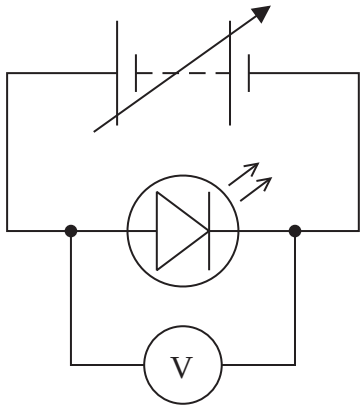
(ii) Explain how using a position sensor with a datalogger will improve the measurement of the time period.

(2)

(Total for Question 2 = 9 marks)

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3 A student used light emitting diodes (LEDs) to determine a value for Planck's constant. He set up the circuit shown.



He increased the potential difference V from zero and recorded the value at which the LED just began to emit light. He repeated this for LEDs that emitted light of different, known frequencies f.

His results are shown in the table.

f/Hz × 10^{14}	V/V
6.38	2.23
5.28	1.69
5.10	1.57
4.69	1.40

(a) Criticise these results.

(1)

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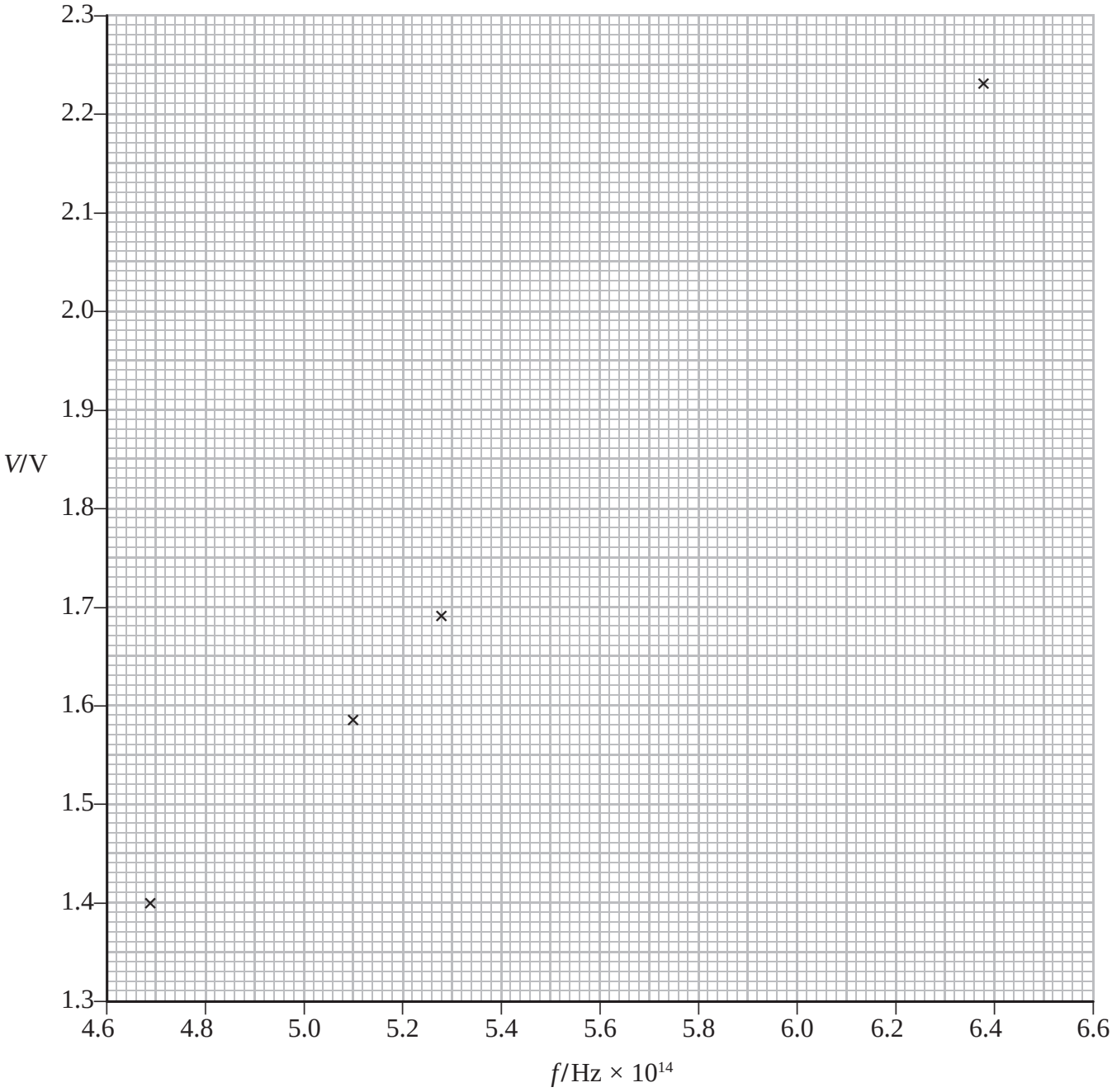
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(b) V and f are related by

$$eV = hf - b$$

where e is the electron charge, h is Planck's constant and b is also a constant.

The student plotted a graph of V against f.



(i) Draw a straight line of best fit on the graph.

(1)

(ii) Use the gradient of your line to determine a value for Planck's constant.

(4)

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Planck's constant = ...

(iii) Determine the percentage difference between your value and the accepted value of Planck's constant.

(1)

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(Total for Question 3 = 7 marks)

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4 The intensity of light emitted by a light bulb varies with the electrical power supplied.

(a) Draw a circuit diagram of the circuit you would use to vary and determine the electrical power supplied to a bulb.

(2)

(b) In an experiment, a second circuit containing a Light Dependent Resistor (LDR) is used to determine the intensity of the light emitted by the bulb as the power supplied is varied. The LDR is placed a certain distance away from the bulb.

(i) State what happens to the resistance of an LDR as the light intensity falling on it increases.

(1)

.....

(ii) State why the distance between the LDR and the bulb should remain constant throughout the experiment.

(1)

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.....

(c) Values of power P and the corresponding light intensity I are shown in the table below.

I/W m^{-2}	P/W		
1900	20.47		
740	13.09		
425	11.09		
220	8.29		
123	6.37		
76	5.45		

It is suggested that I and P are related by

$$I = kP^x$$

where k and x are constants.

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

(2)

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(ii) Use the grid opposite to plot a graph of $\ln I$ against $\ln P$. Use the column(s) in the table for your processed data.

(5)

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

(2)

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.....

.....

x = ...

(Total for Question 4 = 13 marks)

TOTAL FOR PAPER = 40 MARKS

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	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^9\ \text{N m}^2\ \text{C}^{-2}$	
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	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$	
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	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{grav} = mg\Delta h$

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	$hf = \phi + \frac{1}{2}mv^2_{\max}$

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	$Q = Q_0e^{-t/RC}$
In a magnetic field	$F = BIl \sin \theta$ $F = Bqv \sin \theta$ $r = p/BQ$
Faraday's and Lenz's Laws	$\varepsilon = -d(N\phi)/dt$

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

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

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