Write your name here

Surname	Other names

Pearson Edexcel International Advanced Level

Centre Number

Candidate Number

Physics

Advanced
Unit 6: Experimental Physics

Thursday 18 May 2017 – 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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 4 8 4 2 6 A 0 1 1 6

Pearson

Answer ALL questions in the spaces provided.

1 A student determines the viscosity η of oil by measuring its volume flow rate $\frac{V}{t}$ through a horizontal pipe.

The student uses the formula

$$\frac{V}{t} = \frac{\pi P r^4}{8\eta L}$$

P = the pressure difference between the ends of the pipe
r = the internal radius of the pipe
L = the length of the pipe

The pipe is approximately 1cm in diameter.

(a) The student measures the internal diameter of the pipe.

(i) State a suitable instrument for this measurement. **(1)**

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(ii) Explain your choice of instrument. **(2)**

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(iii) State the measuring technique you would use with this instrument to obtain an accurate value for the internal diameter of the pipe. **(1)**

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....

(b) The mean value for the internal diameter of the pipe is 0.995 cm ± 0.003 cm.

Calculate the percentage uncertainty in this measurement. **(1)**

....

....

....

Percentage uncertainty = ...

(c) The student recorded the following values omitting the SI units.

Quantity	Value	Percentage uncertainty
V/t	8.5×10^{-6}	3.5
P	695	0.7
L	2.00	0.5

(i) Show that the unit for η is N s m^{-2}.

(2)

....

....

....

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(ii) Calculate a value for η.

(2)

....

....

....

η = ...

(iii) Calculate the percentage uncertainty in η.

(2)

....

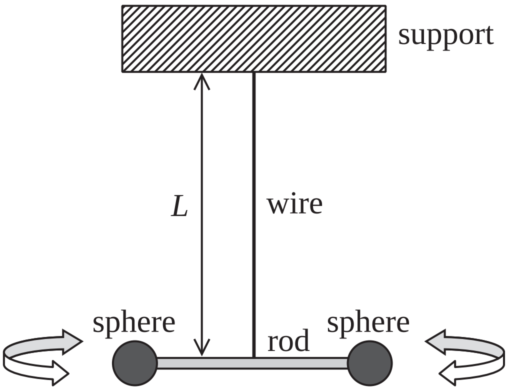
....

....

Percentage uncertainty = ...

(Total for Question 1 = 11 marks)

2 The diagram shows a rotational pendulum. The identical steel spheres perform angular oscillations about a vertical axis through the centre of the rod.



A student investigates how the period of the oscillations T varies with the length of the wire L.

The student also has a metre rule, a stopwatch with a precision of 0.01 s and an optical pin.

(a) Describe how the student can use this apparatus to obtain values for T that are as accurate as possible.

(3)

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(b) The student is given the formula $T = 2\pi\sqrt{\frac{IL}{K}}$ where I and K are constants.

(i) Describe the graph she should plot to obtain a straight line.

(2)

....

....

....

....

(ii) The value K is a constant for the wire.

State how the graph described in (i) can be used to calculate K if I is known.

(1)

....

....

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....

(c) A light gate, attached to a data logger, can be placed so that one of the spheres breaks the light beam as it passes.

Describe how this would improve the accuracy in the measurement of T.

(2)

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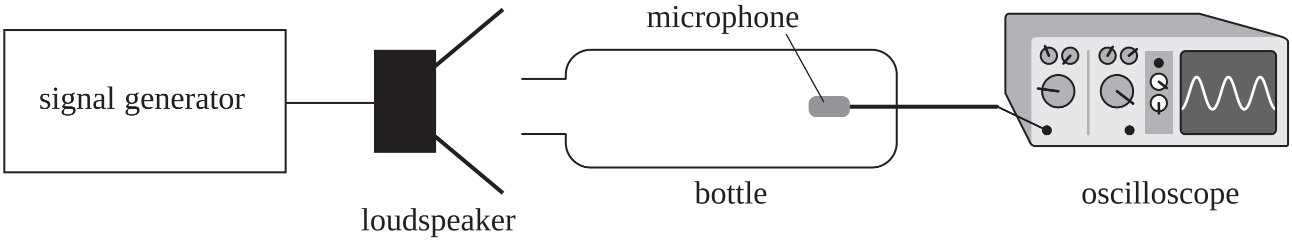
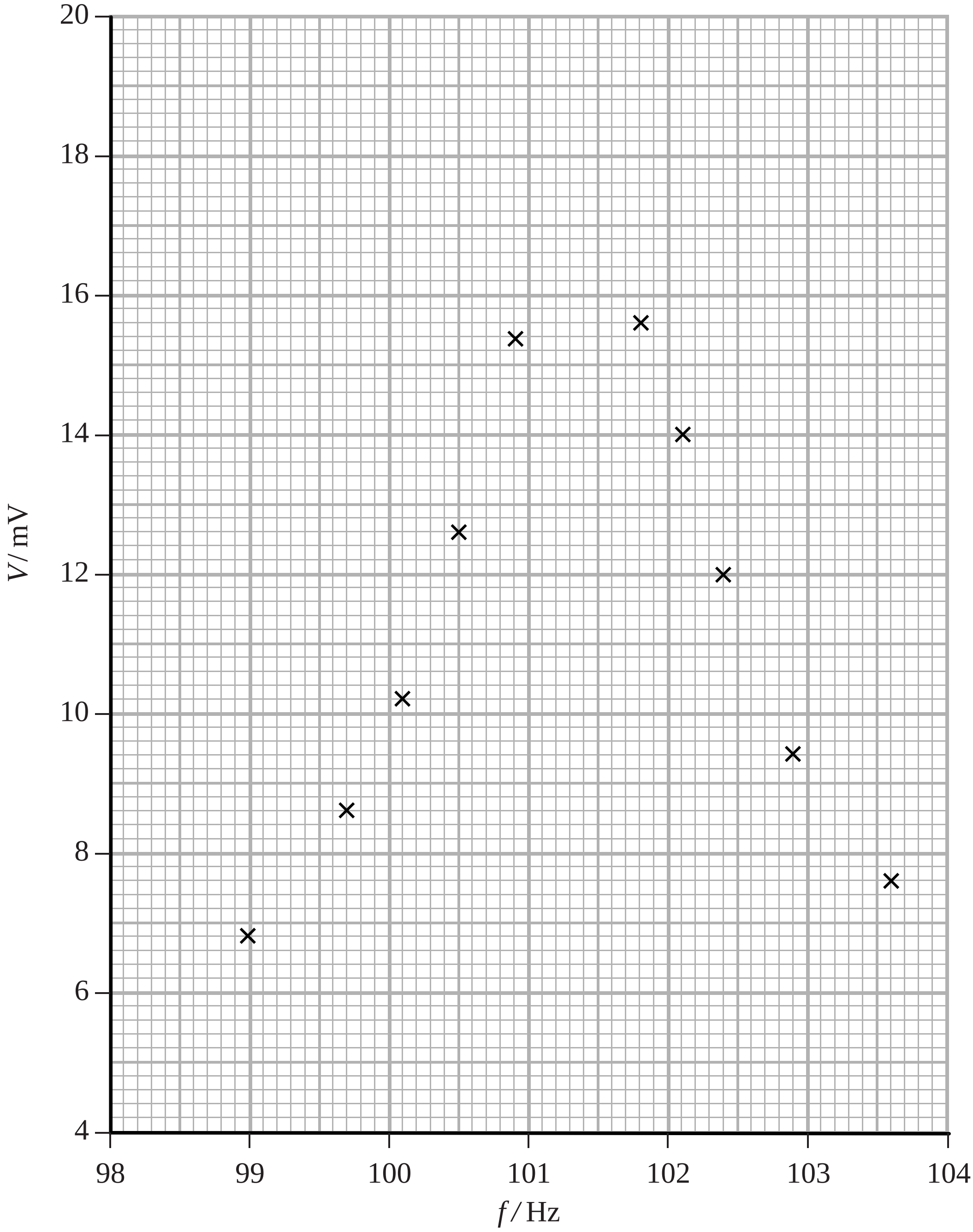
(Total for Question 2 = 8 marks)

3 A student uses the apparatus shown to determine the resonant frequency of the air in a bottle.



The frequency *f* of the sound produced by the loudspeaker is varied using the signal generator. The sound detected by the microphone is displayed as a potential difference *V* on the oscilloscope.

The student plots a graph of the maximum value of *V* for a range of values of *f*.



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

(2)

(ii) Estimate the maximum value of V.

(1)

....

....

(iii) State the resonant frequency f_0 of the bottle.

(1)

....

....

(b) The student takes more readings in the range 100 Hz to 102 Hz.

Suggest how this would increase the accuracy of the value of f_0 obtained.

(1)

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(Total for Question 3 = 5 marks)

4 A student investigated the decay of a sample of protactinium-234 using a Geiger-Müller tube connected to a ratemeter.

The student first measured the background count rate. She recorded the count rate from the sample every 20 s and corrected each value by subtracting the background count rate. The corrected count rates are shown.

Time / s	**Count rate / s^{-1}**	
0	150	
20	126	
40	98	
60	88	
80	70	
100	61	
120	46	
140	39	
160	28	

(a) State the type of error that the student avoided by subtracting the background count rate.
(1)

....

(b) Identify a variable that must be kept constant in this investigation.
(1)

....

(c) The activity of the sample of protactinium is given by the formula

$$A = A_0 e^{-\lambda t}$$

where A is taken as the measured count rate at a time t.

A_0 is the count rate at $t = 0$

λ is the decay constant of protactinium-234

Show that a graph of ln A against t should be a straight line.
(2)

....

....

....

....

(d) Draw a graph of ln *A* against *t* on the grid below. Use the extra column in the table for your processed data.

(5)

(e) Use the graph to determine a value for λ.

(4)

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λ = ...

(f) The half-life of a radioactive isotope is given as $t_{½} = \dfrac{0.69}{\lambda}$.

(i) Calculate a value for the half-life of protactinium-234.

(1)

....

....

....

....

Half-life = ...

(ii) The half-life for this isotope is quoted as 1.2 minutes.

Comment on the accuracy of your answer.

(2)

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(Total for Question 4 = 16 marks)

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	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^{9} \text{ N m}^2 \text{ C}^{-2}$	
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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$

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

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

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

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	$\varepsilon = -d(N\phi)/dt$

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	$\mathrm{d}N/\mathrm{d}t = -\lambda N$
	$\lambda = \ln 2/t_{½}$
	$N = N_0 e^{-\lambda t}$

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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