Write your name here

Surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number	Candidate Number

Physics

Advanced
Unit 6: Experimental Physics

Wednesday 28 January 2015 – 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 ▶

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P 4 5 0 4 0 A 0 1 1 6

PEARSON

Answer ALL questions in the spaces provided.

1 A student made measurements to determine the density of a single microscope slide.

(a) The dimensions of the slide were approximately 8 cm long, 3 cm wide and 1 mm thick.

Complete the table below to show the instruments you would use to make these measurements to an appropriate precision.

(4)

Measurement	Instrument	Precision of instrument
length	metre rule	1 mm
width		
thickness		

(b) The student recorded the following measurements.

Measurement	Reading	Mean
length / mm	75.8 75.9 75.7 75.8	75.8
width / mm	25.8 25.8 25.8 25.8	25.8
thickness / mm	1.01 1.02 0.98 0.99 1.00	1.00

Use these measurements to estimate the percentage uncertainty in the readings for length and thickness.

(2)

....

....

....

....

Percentage uncertainty in length = ... %

Percentage uncertainty in thickness = ... %

(c) The mass of the microscope slide is recorded as 4.82 g with an uncertainty of 0.03 g.

(i) Calculate a value for the density of the slide.

(2)

....

....

Density = ...

(ii) Estimate the percentage uncertainty in your value for the density.
You may assume the uncertainty in the measurement for the width is negligible.

(2)

....

....

Percentage uncertainty = ... %

(iii) The student researched the density of different types of glass and found a value for 'Crown glass' of 2600 ± 100 kg m^{-3}.

Use this information to decide if the slide is made from Crown glass.

(2)

....

....

....

....

(d) Measuring the thickness of a stack of 10 slides would produce a better value for the thickness of one slide.

Explain why.

(2)

....

....

....

....

(Total for Question 1 = 14 marks)

2 A box containing a radioactive source has the following labels.

- Beta emitter only
- Range in air 25 cm

You are to plan an experiment to check that these labels are correct.

Your plan should include:

(a) the apparatus to be used,
(1)

(b) the measurements to be taken,
(3)

(c) a technique to reduce the uncertainty in the measurements,
(1)

(d) how these measurements should be used to check that the labels are correct,
(3)

(e) a comment on safety.
(1)

(Total for Question 2 = 9 marks)

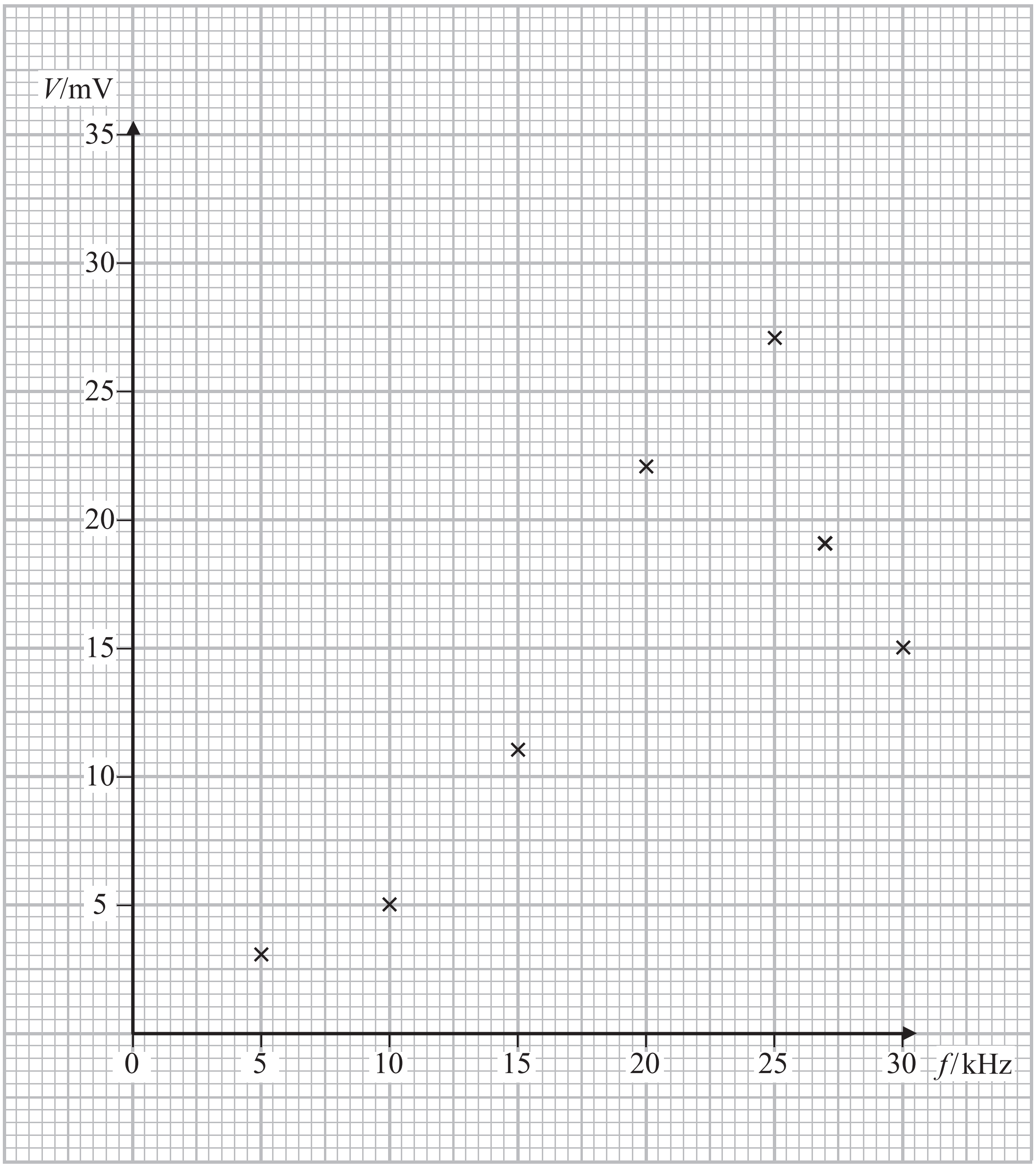
3 In an electrical circuit, as the frequency f of a signal generator is varied the potential difference V across a component also varies. This causes an electrical resonance effect which is similar to mechanical resonance.

The magnitude of V is a maximum at the resonant frequency.

In an experiment using a particular circuit the following measurements were recorded.

f/kHz	V/mV
5	3
10	5
15	11
20	22
25	27
27	19
30	15

(a) A graph of V against f is plotted.



P 4 5 0 4 0 A 0 6 1 6

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

(2)

(ii) Estimate the maximum value of V.

(1)

....

(iii) State the value of the resonant frequency.

(1)

....

(b) Suggest one way in which the experiment could be improved to obtain a more accurate value of the resonant frequency.

(1)

....

....

(Total for Question 3 = 5 marks)

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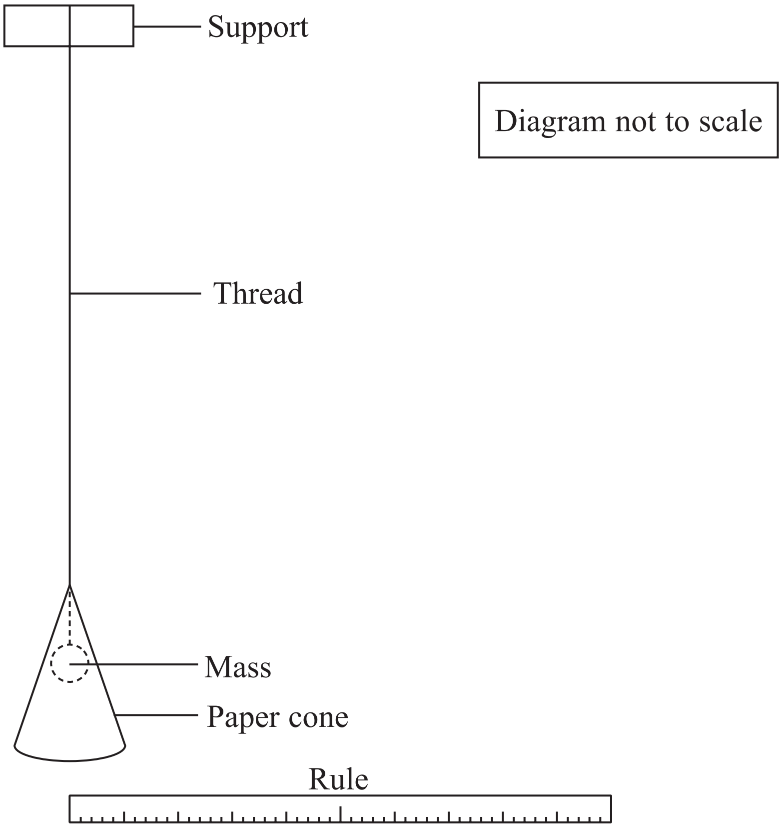
4 A pendulum is made by tying a small mass on to a length of thread. A paper cone is placed over the mass as shown.



(a) The pendulum is pulled to one side and released so that it oscillates. The amplitude of oscillation decreases because the cone provides damping.

(i) Explain how you would use the apparatus above to measure the amplitude. You should add to the diagram.

(2)

....

....

....

(ii) State the uncertainty you would expect in the measurements of amplitude.

(1)

....

(b) It is predicted that the amplitude A is related to the number of oscillations n by

$$A = A_0 e^{-kn}$$

where A_0 is the initial amplitude and k is a constant.

Show that a graph of ln A against n should be a straight line.

(2)

....

....

....

(c) In an experiment to measure A and n the following measurements were recorded.

n	***A*/cm**	
0	20.0	
2	18.2	
4	16.2	
6	14.4	
8	13.2	
10	11.9	

(i) Use the grid opposite to draw a graph of ln A against n. Use the column in the table for your processed data.

(5)

(ii) Use your graph to determine a value for k.

(2)

....

....

....

k = ...

(Total for Question 4 = 12 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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$

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

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

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

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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