

Write your name here

Surname

Other names

**Pearson Edexcel**  
**International**  
**Advanced Level**

Centre Number

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Candidate Number

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# 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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**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  $2600 \pm 100 \text{ kg m}^{-3}$ .

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)





(Total for Question 2 = 9 marks)



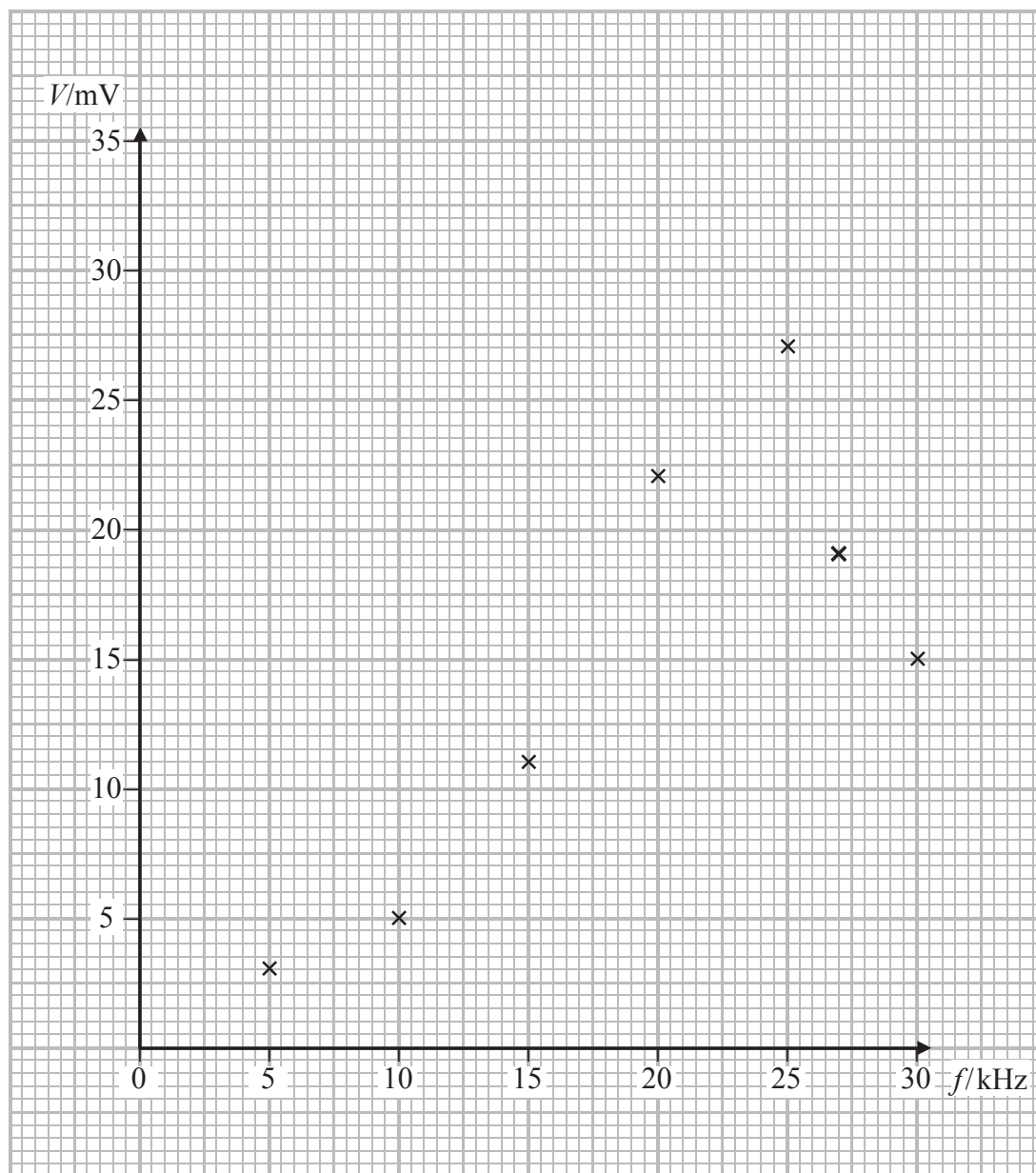
- 3 In an electrical circuit, as the frequency  $f$  of a signal generator is varied the potential difference  $V$  across a component also varies. This causes an electrical resonance effect which is similar to mechanical resonance.

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

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

$f/\text{kHz}$	$V/\text{mV}$
5	3
10	5
15	11
20	22
25	27
27	19
30	15

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



(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)**

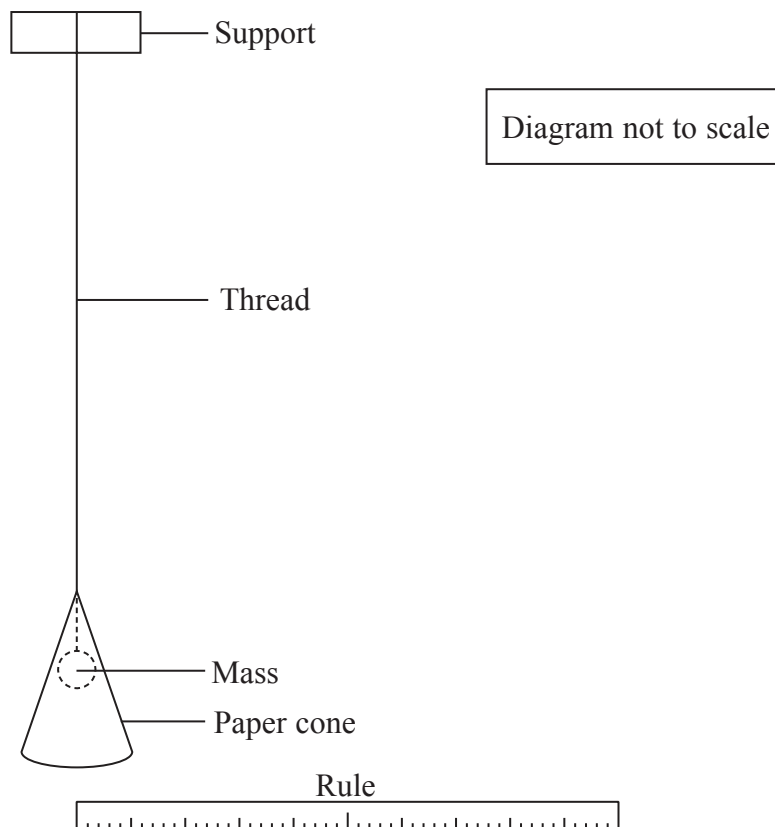


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- 4 A pendulum is made by tying a small mass on to a length of thread. A paper cone is placed over the mass as shown.



- (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.

$n$	$A/\text{cm}$	
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)

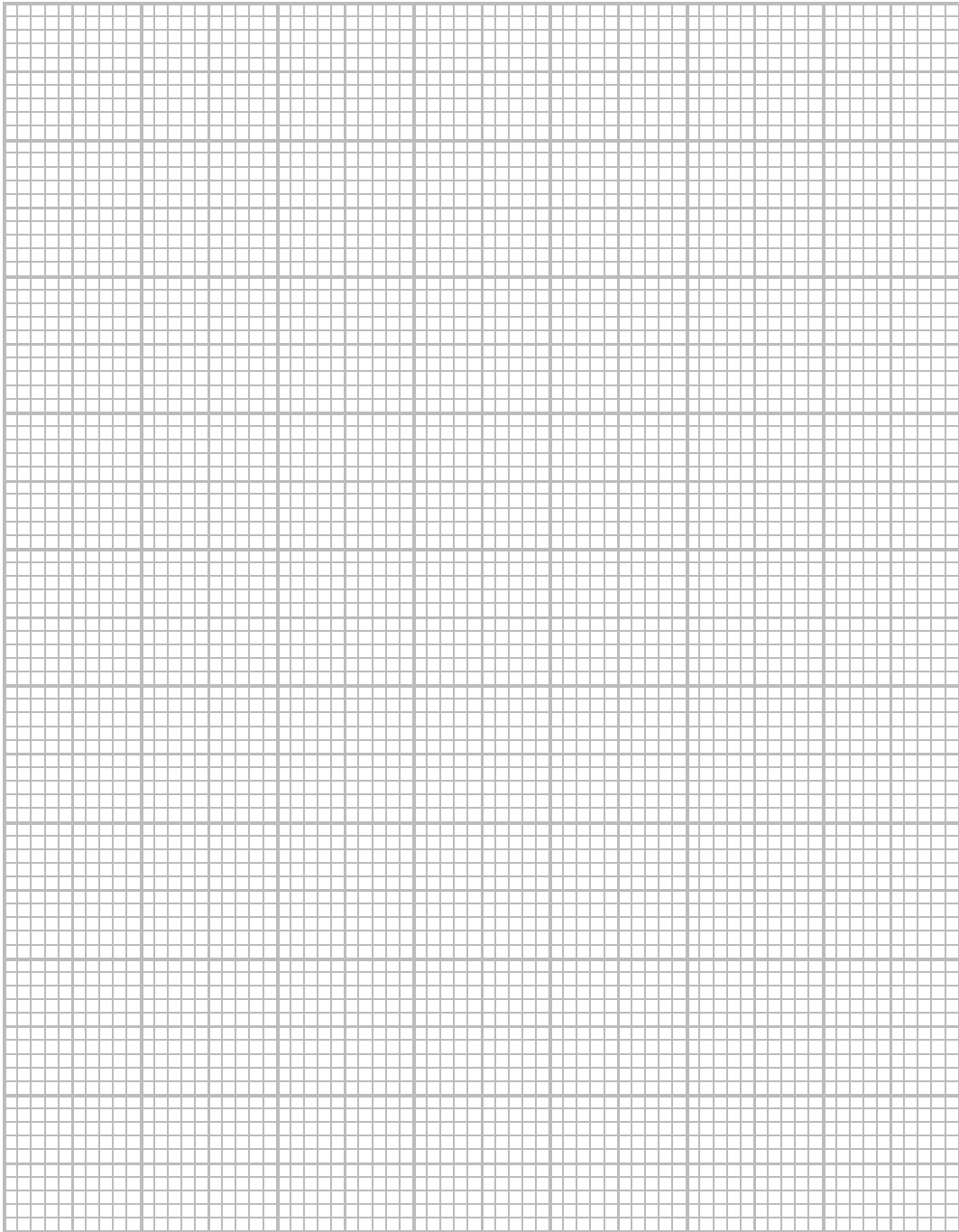
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$k =$  .....





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**(Total for Question 4 = 12 marks)**

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**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	$k = 1/4\pi\epsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
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  $F = Gm_1 m_2 / r^2$

### 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  $v = H_0 d$



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