

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

Thursday 26 January 2017 – 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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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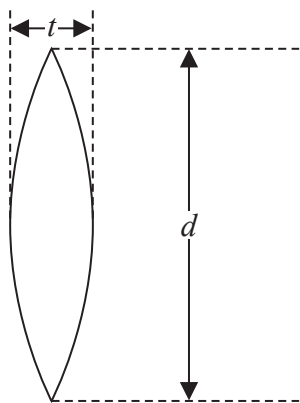
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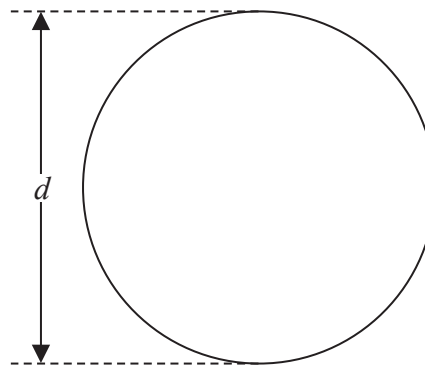

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Answer ALL questions in the spaces provided.

- 1 A student determines a property of a lens called its focal length f . She measures the diameter d of the lens and the thickness t of the lens at its centre.



Side view



Plan view

f is given by

$$f = \frac{d^2}{8t(\mu - 1)}$$

where μ is the refractive index of the glass from which the lens is made.

$$\mu = 1.52$$

- (a) The student measures the diameter d of the lens as $3.9 \text{ cm} \pm 0.1 \text{ cm}$.
- (i) Draw a diagram below to show how she should measure the diameter of the lens using a half-metre rule and two set squares. (1)

- (ii) Describe how she should check that the diameter of the lens is uniform. (1)

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(iii) Calculate the percentage uncertainty in her value of d .

(1)

Percentage uncertainty in $d = \dots\dots\dots$

(b) Using vernier callipers the student measures t as $0.26 \text{ cm} \pm 0.01 \text{ cm}$.

(i) Calculate the percentage uncertainty in the value of t .

(1)

Percentage uncertainty in $t = \dots\dots\dots$

(ii) Calculate a value for f .

(3)

$f = \dots\dots\dots$

(iii) Calculate the percentage uncertainty in the value of f .

(2)

Percentage uncertainty in $f = \dots\dots\dots$

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(iv) Calculate the uncertainty in f .

(1)

Uncertainty in $f =$

(v) Explain which measurement contributes the most to the uncertainty in f .

(2)

(Total for Question 1 = 12 marks)

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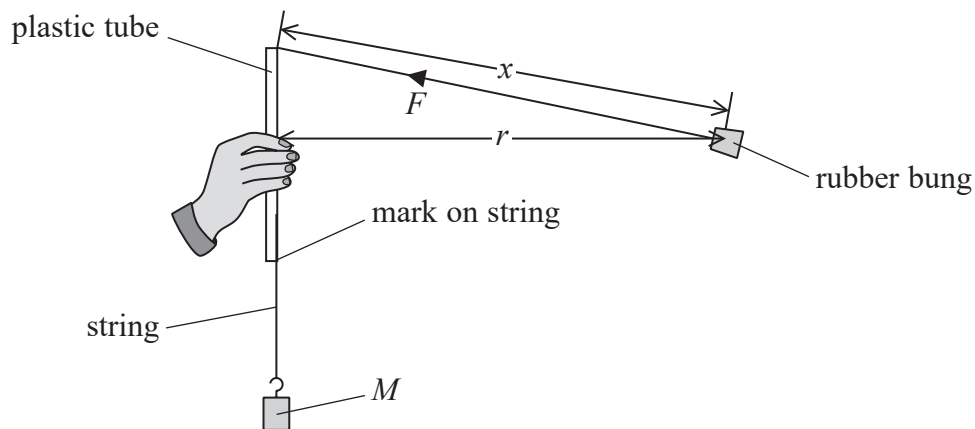
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- 2 A student uses the apparatus shown to rotate a rubber bung of mass m in a horizontal circle of radius r .



The mass M provides a tension F in the string. The vertical component of F maintains the bung in vertical equilibrium and the horizontal component of F causes the bung to move in a circular path.

The bung is rotated at an angular velocity ω , so that the length x does not change.

The mark on the string is kept level with the bottom of the plastic tube as the bung is rotated.

- (a) The period of rotation T is about 1 second.

Describe how the student can obtain an accurate value for T .

(3)

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(b) The variables in this experiment are related by the formula

$$Mg = mx\omega^2$$

where g , m and x are all constant.

(i) Show that $T^2 = 4\pi^2 \frac{mx}{Mg}$ (2)

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(ii) State the graph the student should plot to produce a straight line. (1)

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(c) Describe how the student should use a metre rule to measure x . (2)

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(d) Comment on safety in this experiment. (1)

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(Total for Question 2 = 9 marks)



3 A current-carrying conductor is placed in a uniform magnetic field.

Write a plan for an investigation to determine the relationship between the force on the conductor and the current in the conductor.

The following apparatus is available:

- a sensitive electronic top-pan balance
- a U-shaped magnet with a uniform magnetic field between its poles
- an insulated copper rod for use as the conductor
- connecting wires.

Your plan should include

- (a) a list of the additional apparatus required (2)
- (b) a circuit diagram (1)
- (c) a diagram showing the arrangement of the top-pan balance, the U-shaped magnet and the conductor (2)
- (d) a description of how the investigation is to be performed (3)
- (e) a sketch graph of the expected results. (1)

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Handwriting practice area with 20 horizontal dotted lines.

(Total for Question 3 = 9 marks)



- 4 When a radioactive isotope decays, its activity A at time t is given by the formula

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

where

λ = radioactive decay constant for the isotope

A_0 = activity when $t = 0$

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

(2)

- (b) A particular radioactive source emits nuclear radiation from two isotopes X and Y.

Isotope Y has a shorter half-life than isotope X. The activity of isotope Y becomes negligible after 15 hours.

The table shows how the total activity of this source varies with time.

Time / hours	Total activity / Bq	
0	200	
2	153	
5	107	
8	78	
11	59	
14	45	
17	36	
20	29	
24	21	

- (i) Use the grid opposite to plot a graph of \ln (total activity) against time.

Use the column in the table for your processed data. Note that the presence of isotope Y will lead to a curved graph.

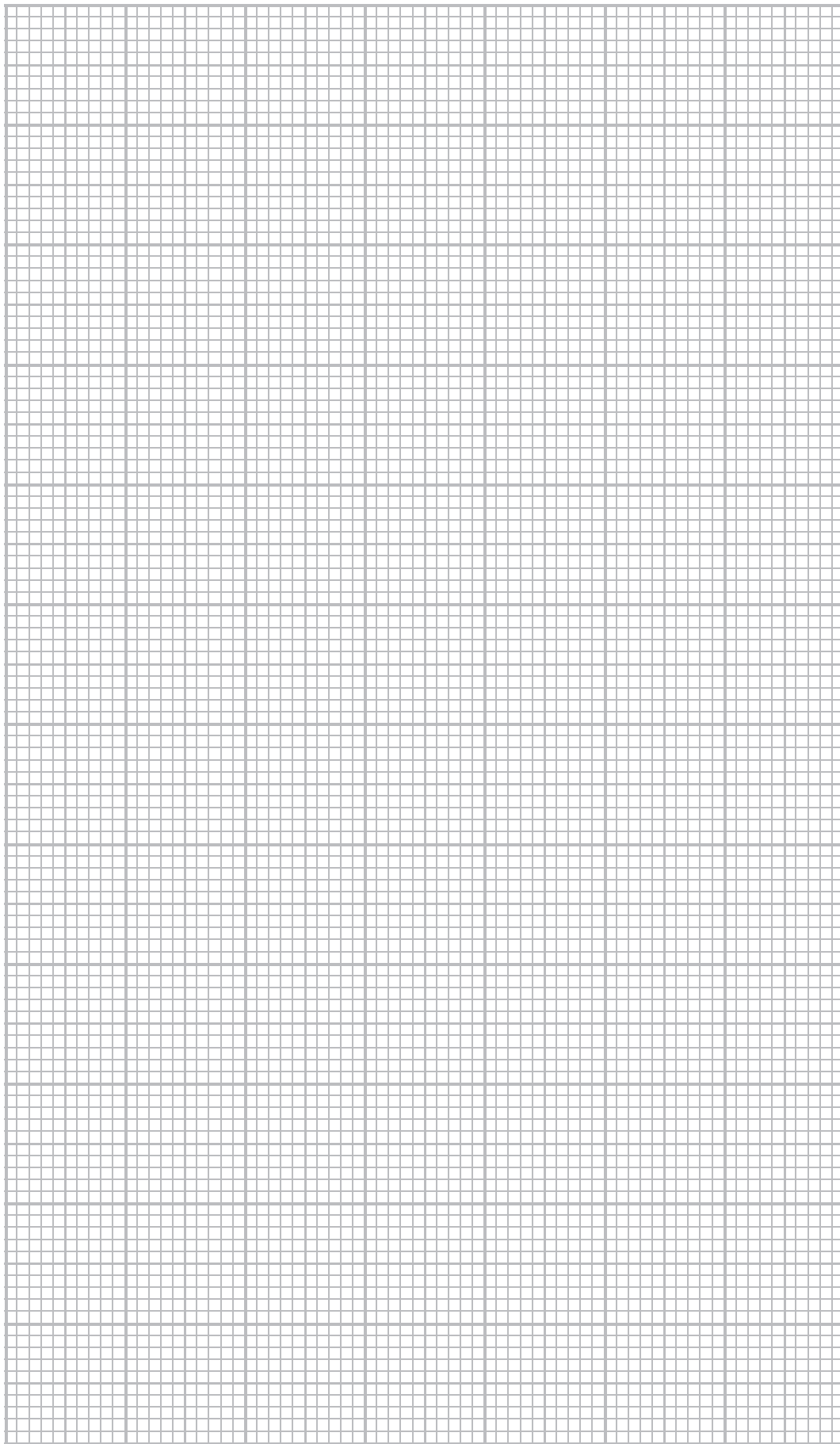
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(ii) Use the gradient of your graph, in a suitable region, to determine a value of λ for isotope X.

(3)

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$\lambda =$

(Total for Question 4 = 10 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	$k = 1/4\pi\epsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
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
 $hf = \phi + \frac{1}{2}mv_{\max}^2$

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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

$$F = kQ_1Q_2/r^2 \text{ where } k = 1/4\pi\epsilon_0$$

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

$$\lambda = h/p$$

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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 $v = H_0 d$

