Write your name here

Surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | Candidate Number

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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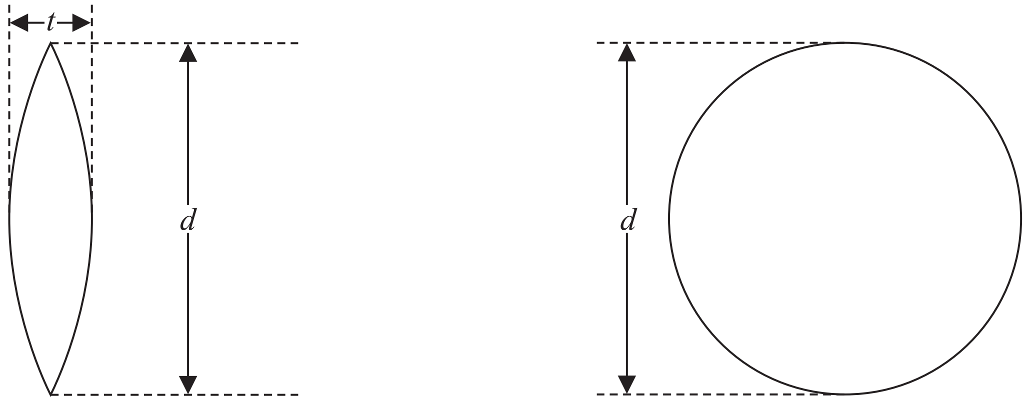
Pearson

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 cm ± 0.1 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* = ...

(b) Using vernier callipers the student measures *t* as 0.26 cm ± 0.01 cm.

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

(1)

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Percentage uncertainty in *t* = ...

(ii) Calculate a value for *f*.

(3)

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f = ...

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

(2)

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Percentage uncertainty in *f* = ...

(iv) Calculate the uncertainty in f.

(1)

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Uncertainty in f = ...

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

(2)

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(Total for Question 1 = 12 marks)

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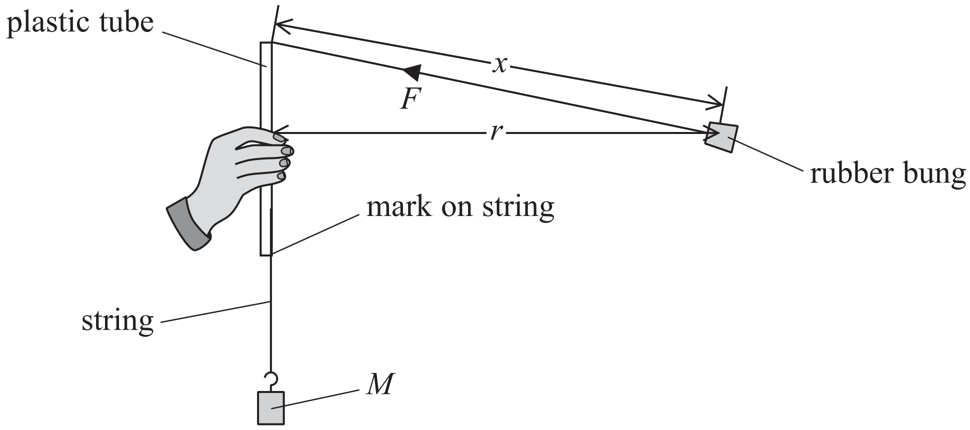
2 A student uses the apparatus shown to rotate a rubber bung of mass m in a horizontal circle of radius r.



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 $T^2 = 4\pi^2 \dfrac{mx}{Mg}$

(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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(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)

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(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.

(5)

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

(3)

λ = ...

(Total for Question 4 = 10 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 $v = H_0 d$