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.

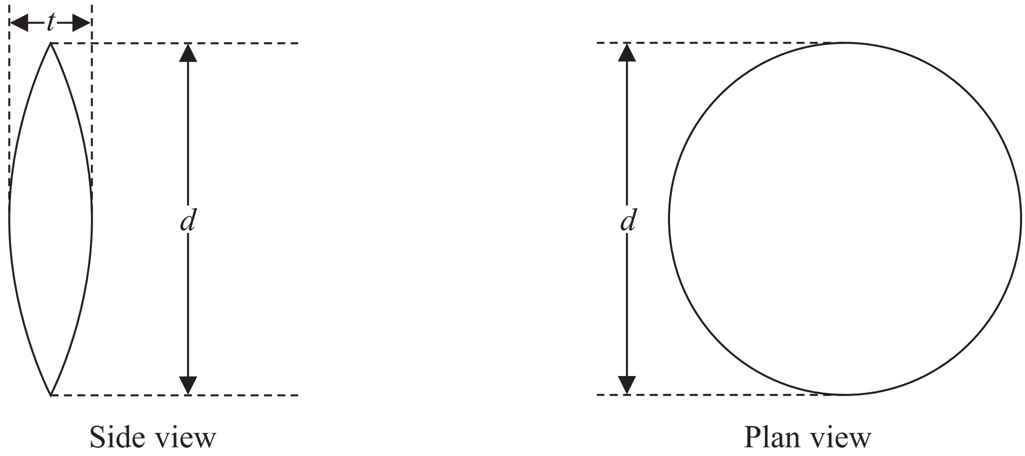
Turn over ▶

1/1/1/1/

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.



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)

....

....

....

(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)

....

....

Percentage uncertainty in t = ...

(ii) Calculate a value for f.

(3)

....

....

....

f = ...

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

(2)

....

....

....

Percentage uncertainty in f = ...

(iv) Calculate the uncertainty in f.

(1)

....

....

Uncertainty in f = ...

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

(2)

....

....

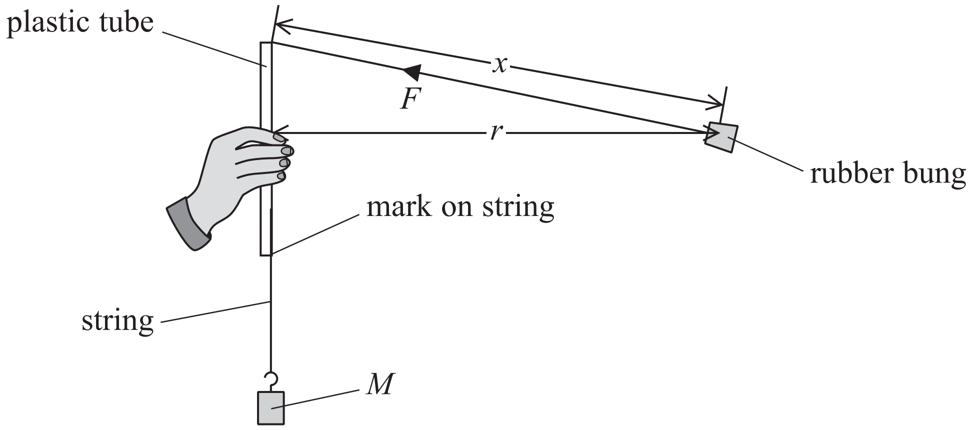
....

....

(Total for Question 1 = 12 marks)

BLANK PAGE

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)

....

....

....

....

....

....

(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)

....

....

....

....

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

(1)

....

....

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

(2)

....

....

....

....

(d) Comment on safety in this experiment.

(1)

....

....

....

(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)**

....

....

....

....

....

....

....

....

....

....

....

....

....

....

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(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.

(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	$g = 9.81\ \mathrm{m\ s^{-2}}$	(close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23}\ \mathrm{J\ K^{-1}}$	
Coulomb's law constant	$k = 1/4\pi\varepsilon_0$ $= 8.99 \times 10^{9}\ \mathrm{N\ m^2\ C^{-2}}$	
Electron charge	$e = -1.60 \times 10^{-19}\ \mathrm{C}$	
Electron mass	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$	
Electronvolt	$1\ \mathrm{eV} = 1.60 \times 10^{-19}\ \mathrm{J}$	
Gravitational constant	$G = 6.67 \times 10^{-11}\ \mathrm{N\ m^2\ kg^{-2}}$	
Gravitational field strength	$g = 9.81\ \mathrm{N\ kg^{-1}}$	(close to Earth's surface)
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\ m^{-1}}$	
Planck constant	$h = 6.63 \times 10^{-34}\ \mathrm{J\ s}$	
Proton mass	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \mathrm{m\ s^{-1}}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\ \mathrm{W\ m^{-2}\ K^{-4}}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$	

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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\%\ \text{efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100$
	$\%\ \text{efficiency} = \dfrac{\text{useful power output}}{\text{total power input}} \times 100$
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	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

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	$\lambda = h/p$

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

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

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	$\lambda_{max} T = 2.898 \times 10^{-3}$ m K
Redshift of electromagnetic radiation	$z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$
Cosmological expansion	$v = H_0 d$