Centre No.						Paper Reference	Surname	Other names
Candidate No.						6 7 3 5 / 2 A	Signature	

Edexcel GCE

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Physics

Advanced Level

Unit Test PHY5 Practical Test

Friday 12 January 2007 – Morning

Time: 1 hour 30 minutes

Question numbers	Leave blank
A	
B	
C	
Total	

Supervisor's data and comments
Comments

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, other names and signature.

PHY5 consists of questions A, B and C. Each question is allowed 20 minutes plus 5 minutes writing-up time. There is a further 15 minutes for writing-up at the end. The Supervisor will tell you which experiment to attempt first.

Write all your results, calculations and answers in the spaces provided in this question booklet.

In calculations you should show all the steps in your working, giving your answer at each stage.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets.

The total mark for this paper is 48.

The list of data, formulae and relationships is printed at the end of this booklet.

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Question A

(a) You are provided with a weighted test tube floating in a beaker of water and an identical tube which is on the bench.

(i) Give the floating test tube a **small**, downward, vertical displacement and let go. Determine the period T of the resulting vertical oscillations.

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(3)

(ii) Use the callipers provided to determine the external diameter D of the test tube on the bench.

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The period of oscillation is given by the formula

$$T = \sqrt{\frac{16\pi m}{D^2 \rho g}}$$

where m = mass of the weighted floating test tube, which is given on the card, and ρ = density of water = 1000 kg m^{-3}.

Use your value for D to calculate a second value for T.

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(3)

(iii) Determine the percentage difference between your two values for T and discuss which of the two values you think is more reliable.

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(3)

(b) You are provided with a length of resistance wire taped to a metre rule and a short length of wire which has been cut from the same reel.

(i) Determine the diameter d of the short length of wire.

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(2)

(ii) Use the ohmmeter to measure the resistance R_1 of a 40.0 cm length of wire and the resistance R_2 of a 90.0 cm length of wire.

R_1..........

R_2..........

Calculate the resistance r per metre length of the wire using the formula

$$r = 2(R_2 - R_1)$$

....

(2)

(iii) The table below, showing resistance per metre length, is taken from a data book:

Gauge	Diameter / mm	Nichrome / $\Omega\,m^{-1}$	Constantan / $\Omega\,m^{-1}$
26	0.4572	6.58	2.98
28	0.3759	9.73	4.41
30	0.3150	13.9	6.29
32	0.2743	18.3	8.29

Use these data to identify the wire that you tested. Explain how you made your decision.

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Suggest why finding the resistance per metre length by subtracting the resistance of two different lengths is a good technique.

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(3)

QA

(Total 16 marks)

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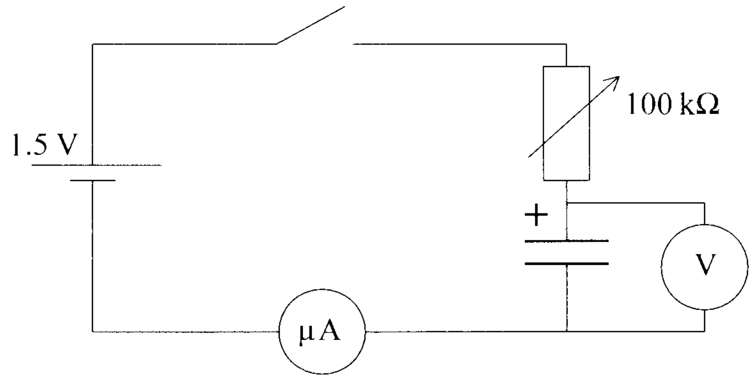
Question B

(a) The circuit shown below has been set up ready for you to use. You are going to record the time t that it takes for a current I to raise the voltage V across the capacitor to the values given in the table.

When you close the switch you will record the initial current I in the circuit. **You will then keep the current constant at this value by adjusting the variable resistor.**



Set the variable resistor to its maximum value. Connect the spare lead across the capacitor. This short circuits the capacitor and discharges it. Once you have done this, disconnect one end of this lead.

Close the switch and simultaneously start the stopwatch. For each value of V shown in the table record the current I and time t. Remember to switch off, set the rheostat to its maximum value and discharge the capacitor each time before you start the experiment.

V / V	I /	t /	Q /
0.20			
0.40			
0.60			
0.80			
1.00			

Calculate the charge Q stored in the capacitor using $Q = It$. Add all the appropriate units to the table headings.

(9)

N 2 4 6 0 1 A 0 4 1 6

Leave blank

(b) Plot a graph of Q against V on the grid below.

(3)

(c) Use the gradient of your graph to determine a value for the capacitance of the capacitor.

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(4)

QB

(Total 16 marks)

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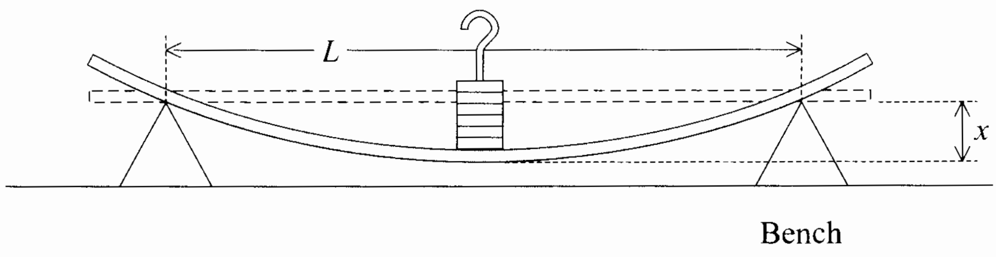
Question C

You are to plan an investigation into the bending of a metre rule on two supports when a load is applied at its centre.

(a) A metre rule is supported symmetrically on two prisms as shown below. A mass is placed at its centre, which causes a depression x of the centre of the rule.



It is thought that for a given load, the depression x is related to the separation L of the supports by an equation of the form

$$x = kL^r$$

where k and r are constants.

Describe how you would carry out an experiment to investigate this relationship. You should explain how you would use a graph of $\ln x$ against $\ln L$ to find a value for r.

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(5)

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(b) The following data were obtained in such an experiment.

L / mm	x / mm		
900	13.7		
800	9.5		
700	6.5		
600	4.2		
500	2.4		

(i) Use the blank columns to add your processed data and then plot a suitable graph on the grid opposite to enable you to determine a value for r.

(5)

(ii) Use your graph to find a value for r.

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(2)

(c) The depression x also depends on the width w of the rule. Describe how you would make accurate measurements with vernier callipers of

(i) width w ....

....

....

(ii) the depression x ....

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....

....

(4)

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QC

(Total 16 marks)

TOTAL FOR PAPER: 48 MARKS

END

List of data, formulae and relationships

Data

Speed of light in vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$	
Gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	
Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to the Earth)
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to the Earth)
Elementary (proton) charge	$e = 1.60 \times 10^{-19} \text{ C}$	
Electronic mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$	
Electronvolt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	
Unified atomic mass unit	$\text{u} = 1.66 \times 10^{-27} \text{ kg}$	
Molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$	
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$	
Coulomb law constant	$k = 1/4\pi\varepsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ N A}^{-2}$	

Rectilinear motion

For uniformly accelerated motion:

$$v = u + at$$

$$x = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2ax$$

Forces and moments

Moment of F about O = $F \times$ (Perpendicular distance from F to O)

Sum of clockwise moments about any point in a plane = Sum of anticlockwise moments about that point

Dynamics

Force $\quad F = m\dfrac{\Delta v}{\Delta t} = \dfrac{\Delta p}{\Delta t}$

Impulse $\quad F\Delta t = \Delta p$

Mechanical energy

Power $\quad P = Fv$

Radioactive decay and the nuclear atom

Activity $\quad A = \lambda N \quad$ (Decay constant λ)

Half-life $\quad \lambda t_{\frac{1}{2}} = 0.69$

Electrical current and potential difference

Electric current $I = nAQv$

Electric power $P = I^2R$

Electrical circuits

Terminal potential difference $V = \mathcal{E} - Ir$ (E.m.f. $\mathcal{E}$; Internal resistance r)

Circuit e.m.f. $\Sigma\mathcal{E} = \Sigma IR$

Resistors in series $R = R_1 + R_2 + R_3$

Resistors in parallel $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Heating matter

Change of state: energy transfer $= l\Delta m$ (Specific latent heat or specific enthalpy change l)

Heating and cooling: energy transfer $= mc\Delta T$ (Specific heat capacity c; Temperature change ΔT)

Celsius temperature $\theta/°\mathrm{C} = T/\mathrm{K} - 273$

Kinetic theory of matter

Temperature and energy $T \propto$ Average kinetic energy of molecules

Kinetic theory $p = \frac{1}{3}\rho\langle c^2\rangle$

Conservation of energy

Change of internal energy $\Delta U = \Delta Q + \Delta W$ (Energy transferred thermally ΔQ; Work done on body ΔW)

Efficiency of energy transfer $= \frac{\text{Useful output}}{\text{Input}}$

Heat engine maximum efficiency $= \frac{T_1 - T_2}{T_1}$

Circular motion and oscillations

Angular speed $\omega = \frac{\Delta\theta}{\Delta t} = \frac{v}{r}$ (Radius of circular path r)

Centripetal acceleration $a = \frac{v^2}{r}$

Period $T = \frac{1}{f} = \frac{2\pi}{\omega}$ (Frequency f)

Simple harmonic motion:

displacement $x = x_0 \cos 2\pi ft$

maximum speed $= 2\pi f x_0$

acceleration $a = -(2\pi f)^2 x$

For a simple pendulum $T = 2\pi\sqrt{\frac{l}{g}}$

For a mass on a spring $T = 2\pi\sqrt{\frac{m}{k}}$ (Spring constant k)

Waves

Intensity $I = \frac{P}{4\pi r^2}$ (Distance from point source r; Power of source P)

Superposition of waves

Two slit interference $\lambda = \frac{xs}{D}$ (Wavelength λ; Slit separation s; Fringe width x; Slits to screen distance D)

Quantum phenomena

Photon model $E = hf$ (Planck constant h)

Maximum energy of photoelectrons $= hf - \varphi$ (Work function φ)

Energy levels $hf = E_1 - E_2$

de Broglie wavelength $\lambda = \frac{h}{p}$

Observing the Universe

Doppler shift $\frac{\Delta f}{f} = \frac{\Delta\lambda}{\lambda} \approx \frac{v}{c}$

Hubble law $v = Hd$ (Hubble constant H)

Gravitational fields

Gravitational field strength $g = F/m$

for radial field $g = Gm/r^2$, numerically (Gravitational constant G)

Electric fields

Electrical field strength $E = F/Q$

for radial field $E = kQ/r^2$ (Coulomb law constant k)

for uniform field $E = V/d$

For an electron in a vacuum tube $e\Delta V = \Delta(\frac{1}{2}m_e v^2)$

Capacitance

Energy stored $W = \frac{1}{2}CV^2$

Capacitors in parallel $C = C_1 + C_2 + C_3$

Capacitors in series $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

Time constant for capacitor discharge $= RC$

Magnetic fields

Force on a wire	$F = BIl$	
Magnetic flux density (Magnetic field strength)		
in a long solenoid	$B = \mu_0 nI$	(Permeability of free space μ_0)
near a long wire	$B = \mu_0 I / 2\pi r$	
Magnetic flux	$\Phi = BA$	
E.m.f. induced in a coil	$\mathcal{E} = -\dfrac{N\Delta\Phi}{\Delta t}$	(Number of turns N)

Accelerators

Mass-energy	$\Delta E = c^2 \Delta m$
Force on a moving charge	$F = BQv$

Analogies in physics

Capacitor discharge	$Q = Q_0 e^{-t/RC}$
	$\dfrac{t_{\frac{1}{2}}}{RC} = \ln 2$
Radioactive decay	$N = N_0 e^{-\lambda t}$
	$\lambda t_{\frac{1}{2}} = \ln 2$

Experimental physics

$$\text{Percentage uncertainty} = \frac{\text{Estimated uncertainty} \times 100\%}{\text{Average value}}$$

Mathematics

$$\sin(90° - \theta) = \cos\theta$$

$$\ln(x^n) = n \ln x$$

$$\ln(e^{kx}) = kx$$

Equation of a straight line	$y = mx + c$	
Surface area	cylinder $= 2\pi rh + 2\pi r^2$	
	sphere $= 4\pi r^2$	
Volume	cylinder $= \pi r^2 h$	
	sphere $= \frac{4}{3}\pi r^3$	
For small angles:	$\sin\theta \approx \tan\theta \approx \theta$	(in radians)
	$\cos\theta \approx 1$	

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Paper Reference: 6735/2A
Question A
(b) iii

Table below, showing Resistance per metre length, is taken from a data book:

Gauge	Diameter / mm	Nichrome / Ωm^{-1}	Constantan / Ωm^{-1}
20	0.91	2.0	0.76
23	0.59	4.6	1.80
26	0.45	8.8	2.98
28	0.37	12.8	4.41

Use these data to identify the wire that you tested. Explain how you made your decision.