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

Edexcel GCE

May/June 2009

Advanced Level

Physics

Unit Test PHY5 Practical Test (International)

Time: 1 hour 30 minutes

For Examiner's use only
For Team Leader's use only

Question numbers	Leave blank
A	
B	
C	
Total	

Supervisor's Data and Comments		
A	Period T/s	
B	Tick box if candidate needed assistance to change the meter setting	
	Tick box if candidate needed assistance to set up the circuit	
	f/Hz	

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) Measure, as accurately as possible, the width a and the thickness b of the metre rule which is clamped to the bench.

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(3)

(b) Check that this metre rule is clamped so that a length $x = 950$ mm is projecting.

You will need to measure the vertical depression y of the end of the rule when a mass $M = 400$ g is hung from the end of the rule.

Secure the 400 g mass to the end of the rule with a small piece of tape.

(i) Draw a diagram of your arrangement to show how you propose to measure the depression y.

(ii) Record your measurements to determine y.

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....

(4)

Leave blank

(iii) A property of the wood from which the rule is made, called its Young modulus E, is given by

$$E = \frac{4Mgx^3}{yab^3}$$

Use the data from your experiment to calculate a value for E.

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(3)

(c) (i) Give the mass a small vertical displacement, release it, and determine the period T of the ensuing vertical oscillations.

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(3)

(ii) Calculate a second value for E from the equation

$$E = \frac{16\pi^2 Mx^3}{ab^3T^2}$$

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(2)

(iii) State, with a reason, which of your two values for E you consider to be the more reliable.

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(1)

QA

(Total 16 marks)

Leave blank

Question B

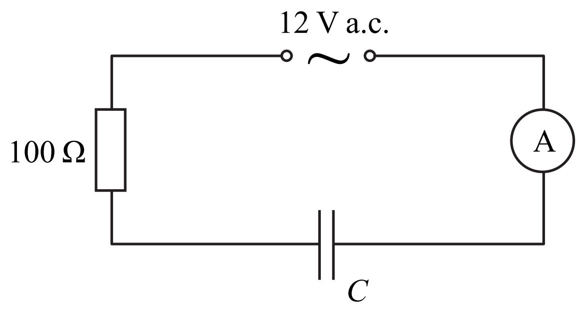
(a) (i) Check that the meter is set on the 20 V a.c. range. Connect this voltmeter across the a.c. power supply, switch on, and record the potential difference V. Switch off.

V = ...

DO NOT ADJUST THE POWER SUPPLY ONCE YOU HAVE DONE THIS.

Change the meter setting so that it is on the 200 mA a.c. range.

Set up the circuit below with $C = 22\ \mu F$. Before switching on, you **must** ask the Supervisor to check your circuit. If your circuit is not correct, the Supervisor will correct it for you. You will only lose 2 marks for this.



(2)

(ii) Switch on and record the current I. Put this value of I in the table below.

C / μF	I /	Z /	Z^2 /	$1/C^2$ /10^8 F^{-2}
22				20.7
32				9.8
47				4.5
57				3.1
69				2.1
79				1.6

Using the capacitors singly and in *parallel* combinations, find the current for the values of capacitance shown in the table.

Complete the table by adding the units and calculating values for Z and Z^2, where Z is given by $Z = V / I$.

(7)

Leave blank

(b) Plot a graph of Z^2 against $1/C^2$ on the grid below.

(3)

QUESTION B CONTINUES ON THE NEXT PAGE

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(c) (i) Determine the gradient S of your graph.

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(ii) Determine a value for the frequency f of the a.c. supply given that

$$f = \frac{1}{2\pi\sqrt{S}}$$

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(4)

QB

(Total 16 marks)

Leave blank

Question C

You are to plan an investigation of how the resistance of a thermistor varies with temperature. You are then to analyse a set of data from such an experiment.

(a) (i) Draw a diagram of the arrangement you would use to measure the resistance of a thermistor at different temperatures in the range 10 °C to 70 °C.

(3)

(ii) Describe how you would carry out the experiment and state any precautions that you would take to improve the accuracy of your results.

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(3)

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(b) A student suggests that the resistance R of a thermistor may be related to its celsius temperature θ by an equation of the form

$$R = R_0 e^{-a\theta}$$

where R_0 is the resistance at 0 °C and a is a constant.

Explain how a graph of ln R against θ would enable you to find values for R_0 and the constant a.

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(2)

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

θ / °C	R / kΩ	
10.0	11.54	
20.0	7.50	
30.0	4.76	
40.0	3.16	
50.0	2.05	
60.0	1.21	
70.0	0.67	

Add values of ln R to the table and then plot a graph of ln R against θ on the grid opposite.

Leave blank

(5)

QUESTION C CONTINUES ON THE NEXT PAGE

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(d) (i) Over what range of temperatures do the results of this experiment suggest that the proposed equation is correct?

....

(ii) Use your graph to estimate a value for R_0, the resistance of the thermistor at 0 °C.

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(3)

QC

(Total 16 marks)

TOTAL FOR PAPER: 48 MARKS

END

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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	$h = 6.62 \times 10^{-34}\ \text{J s}$	
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 $\quad \lambda t_{\frac{1}{2}} = 0.69$

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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	$\theta/°C = T/K - 273$	

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 $= 2\pi fx_0$

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

Experimental physics

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

Mathematics

$$\sin(90° - \theta) = \cos\theta$$

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

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

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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