Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	7	3	5	/	0	1	Signature	

Paper Reference(s)

6735/01

Edexcel GCE

Physics

Advanced Level

Unit Test PHY5

Thursday 14 June 2007 – Morning

Time: 1 hour

Materials required for examination	Items included with question papers
Nil	Nil

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
Total	

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your signature, surname and initials.
Answer **ALL** questions in the spaces provided in this question paper.
In calculations you should show all the steps in your working, giving your answer at each stage.
Calculators may be used.
Include diagrams in your answers where these are helpful.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets.
There are five questions in this paper. The total mark for this paper is 40.
The list of data, formulae and relationships is printed at the end of this booklet.

Advice to Candidates

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

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1. Communication satellites are often placed in geostationary orbit. The speed v of a geostationary satellite is given by the expression

$$v = \omega r$$

where r is the radius of the orbit.

(a) A student calculates that ω has the numerical value of 7.27×10^{-5}. Show how he arrives at this figure.

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State the unit of ω.

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(3)

(b) Hence, or otherwise, calculate the height of such satellites above the Earth's surface, given that the Earth has a mass of 5.98×10^{24} kg and a radius of 6.38×10^{6} m.

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Height above Earth's surface = ...

(4)

Q1

(Total 7 marks)

N 2 6 1 4 8 A 0 2 1 6

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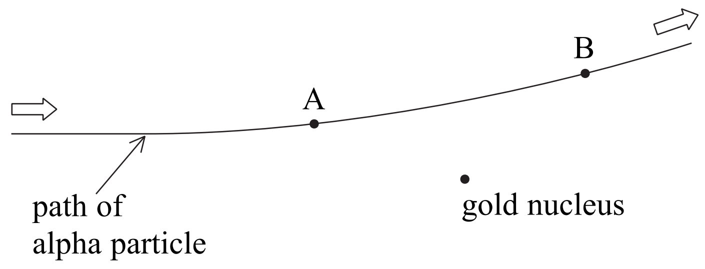
2. The diagram shows the path of an alpha particle, ${}^{4}_{2}He$, as it closely approaches and then moves away from a gold nucleus, ${}^{197}_{79}Au$.



(i) Add to the diagram the direction of the electric force acting on the alpha particle at each of the points A and B.

(1)

(ii) At point A the distance of the alpha particle from the nucleus is 1.5×10^{-13} m. Calculate the magnitude of the force acting on the alpha particle at this point.

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Magnitude of force = ...

(3)

(iii) How does the speed of the alpha particle vary as it moves from A to B?

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(1)

Q2

(Total 5 marks)

N 2 6 1 4 8 A 0 3 1 6

Turn over

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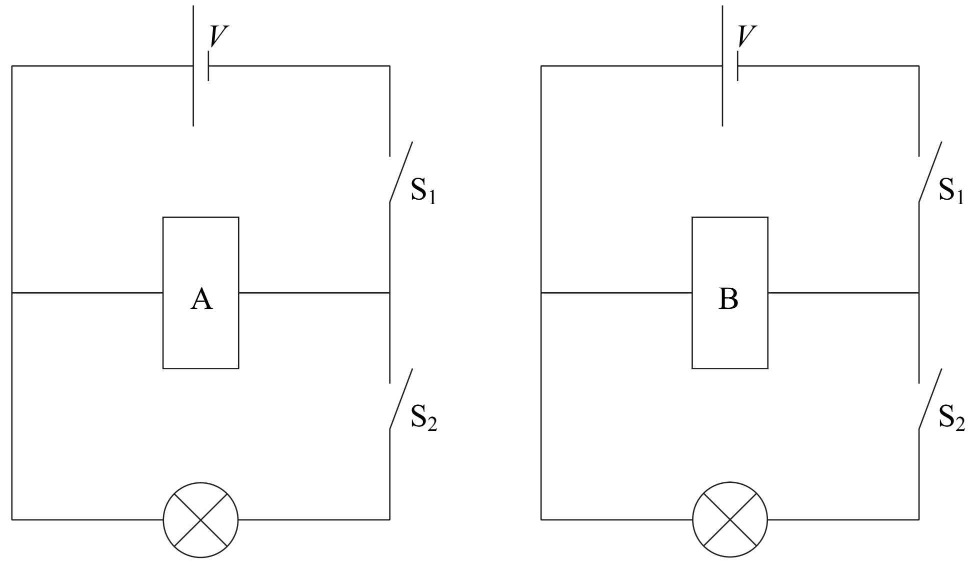
3. Two circuits are set up as shown below. Boxes A and B each conceal an arrangement of two identical capacitors. The circuits are identical in every way apart from the arrangement of the capacitors.



The switches S_1 are closed for a few seconds and then opened. The switches S_2 are then closed. The lamp connected to box A is seen to light for longer than that connected to box B.

(a) (i) State how the capacitors are connected in each box.

Box A ....

Box B ....

(1)

(ii) Explain your answer in terms of the electrical energy stored by the capacitors in each box. You should refer to any relevant formulae to support your explanation.

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(4)

Leave blank

(b) A large value resistor is placed in each circuit between the lamp and S_2. The procedure described earlier in the question is then repeated.

State and explain what would be observed.

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(2)

(c) State and explain what would have been observed if the large value resistor had been connected between S_1 and the cell in each circuit.

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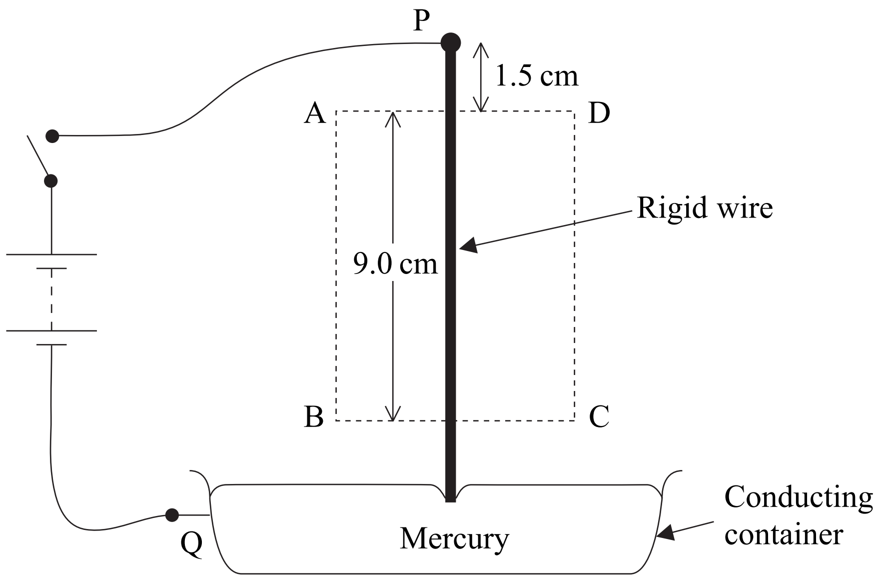
(2)

Q3

(Total 9 marks)

Leave blank

4. The diagram shows a rigid wire pivoted at the point P so that it is free to move in a vertical plane. The lower end of the wire dips into mercury. The arrangement is connected to a circuit at the points P and Q. A uniform magnetic field of flux density 4.0×10^{-2} T acts over the area ABCD and is directed perpendicularly into the page.



(i) When the switch is closed the wire is seen to continually 'kick' out of the mercury and then return to it. Explain, with reference to the moments that act on the wire, why it moves like this. You may be awarded a mark for the clarity of your answer.

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(5)

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(ii) The electromagnetic force on the wire may be assumed to act at the midpoint of the part of the wire which lies in the magnetic field. The initial moment of this force about P, produced when the switch is closed, is 5.0×10^{-4} N m. Show that the magnitude of the force is about 8×10^{-3} N.

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(3)

(iii) Calculate the current in the circuit when the switch is closed.

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Current = ...

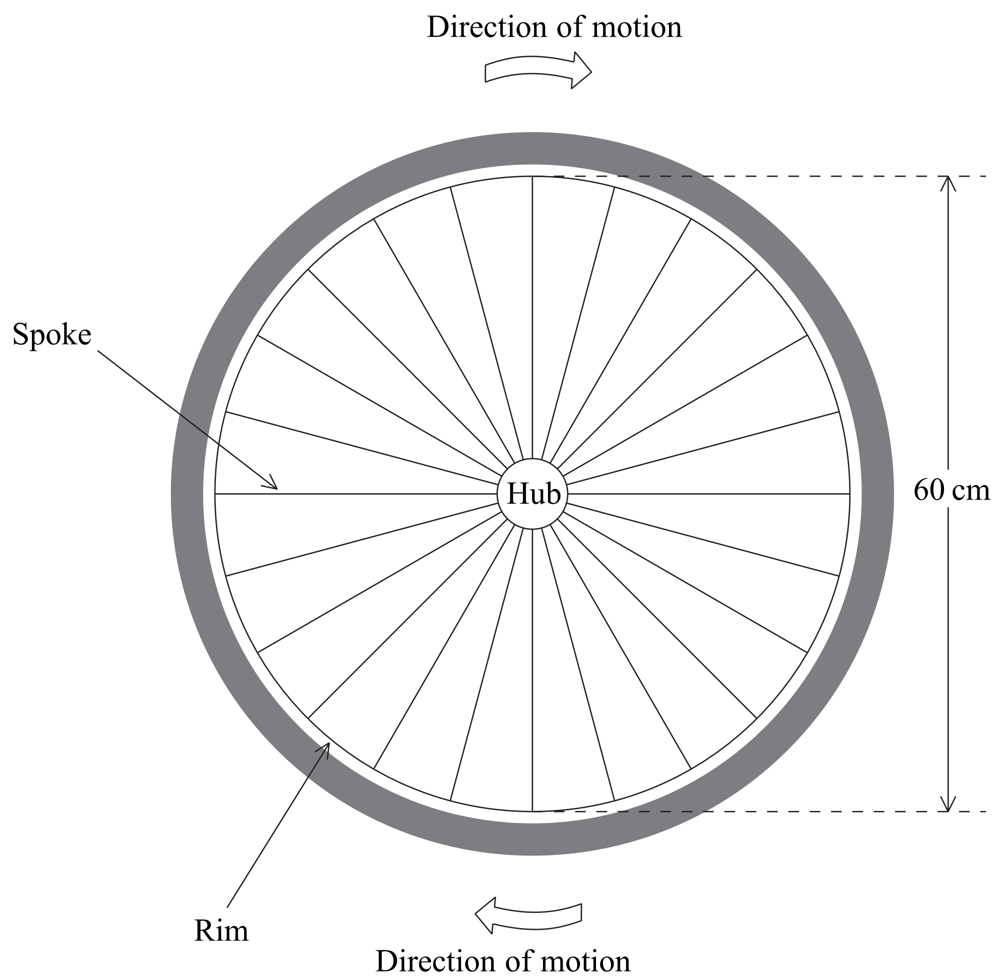
(2)

Q4

(Total 10 marks)

Leave blank

5. A student is experimenting with a bicycle wheel. He turns the bicycle upside down and spins the wheel in a vertical plane at a constant rate. The diagram shows the wheel. At the place where the experiment is performed, the Earth's magnetic field is in a horizontal direction. It acts into and perpendicular to the paper.



(a) A constant e.m.f. is induced across the length of each spoke.

(i) Label the hub and rim either plus or minus to show the polarity of the e.m.f.

(1)

(ii) Explain why a constant e.m.f. is induced.

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(2)

Leave blank

(iii) The magnitude of the e.m.f. is 25 μV. Calculate the time it takes for the wheel to complete one revolution. Assume the area of the hub is negligible.

Assume that the Earth's magnetic flux density has a value of 2.8×10^{-5} T.

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Time = ...

(3)

(b) State and explain what effect, if any, there would be on the magnitude of this e.m.f. in each of the following cases.

(i) The student turns the bicycle so that the wheel is still spinning in a vertical plane, but the plane is now at 45° to the Earth's field.

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(ii) The student causes the wheel to accelerate.

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(iii) The student turns the bicycle so that the wheel spins in a horizontal plane.

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(3) **Q5**

(Total 9 marks)

TOTAL FOR PAPER: 40 MARKS

END

List of data, formulae and relationships

Data

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

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	$P = I^2 R$	

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

Superposition of waves

Two slit interference $\lambda = \dfrac{xs}{D}$ (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 $\lambda = \dfrac{h}{p}$

Observing the Universe

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

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 $e\Delta V = \Delta(\tfrac{1}{2}m_e v^2)$

Capacitance

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

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

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

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	$\varepsilon = -\dfrac{N\Delta\Phi}{\Delta t}$	(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	$\text{cylinder} = 2\pi rh + 2\pi r^2$	
	$\text{sphere} = 4\pi r^2$	
Volume	$\text{cylinder} = \pi r^2 h$	
	$\text{sphere} = \frac{4}{3}\pi r^3$	
For small angles:	$\sin\theta \approx \tan\theta \approx \theta$	(in radians)
	$\cos\theta \approx 1$	

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