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

Monday 22 January 2007 – Morning

Time: 1 hour

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
Total	

Materials required for examination	Items included with question papers
Nil	Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
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: e.g. **(2)**.
There are six questions in this question 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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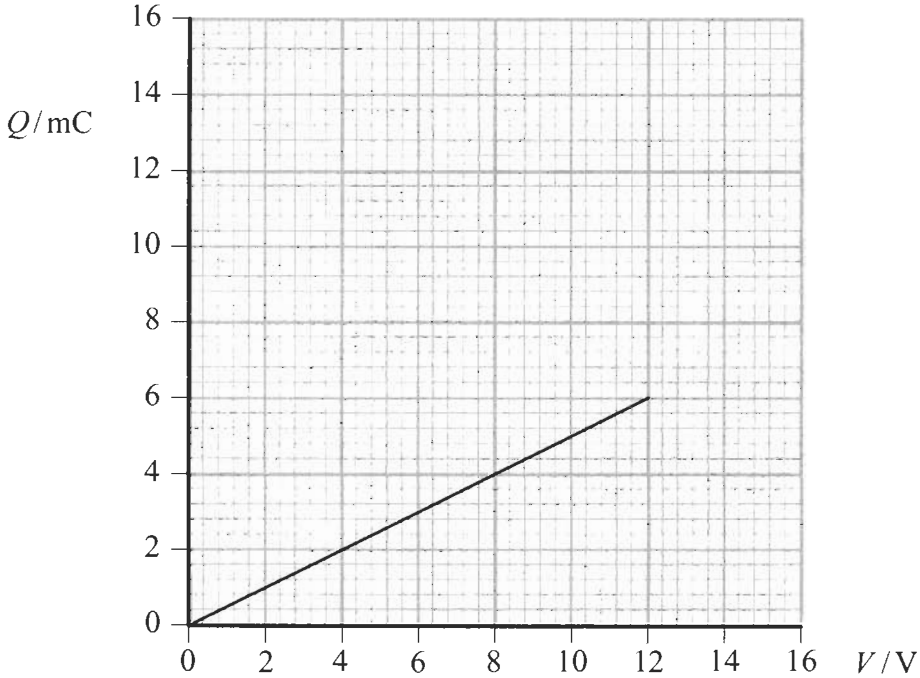
1. The graph shows how the charge, Q, stored on a capacitor varies with the potential difference, V, applied to it.



(i) Use the graph to determine the capacitance of the capacitor.

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Capacitance = ...

(1)

(ii) What feature of the graph gives the electrical energy stored by the capacitor?

....

(1)

(iii) Hence, or otherwise, calculate the electrical energy stored by the capacitor when charged to a potential difference of 12 V.

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Energy stored = ...

(2)

Leave blank

(iv) A 2000 μF capacitor is now charged by steadily increasing the potential difference between its plates until it stores 36 mJ of electrical energy. Add to the graph a line that would represent this charging process. The lines below are for any calculations you need to make.

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(2) **Q1**

(Total 6 marks)

Leave blank

2. (a) Use Newton's law for the gravitational force between point masses to calculate the weight of a man of mass 70 kg standing on the Earth's surface. Assume that the Earth has a radius of 6.4×10^6 m and that its mass, 6.0×10^{24} kg, is concentrated at a point at its centre.

....

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Man's weight = ...

(2)

(b) (i) The Earth takes one day to rotate about an axis through its geographic North and South poles. Show that the tangential speed of a point on the equator is about 470 m s^{-1}.

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....

(2)

(ii) Hence calculate the centripetal force needed to keep a 70 kg man on the Earth's surface at the equator.

....

....

Centripetal force = ...

(1)

(iii) Explain why this leads to a difference between the measured weight of the 70 kg man at the equator and his weight as given by Newton's law of gravitation.

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(2)

Q2

(Total 7 marks)

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3. (a) State one difference between the electric field of an isolated point charge and the electric field between oppositely charged parallel plates.

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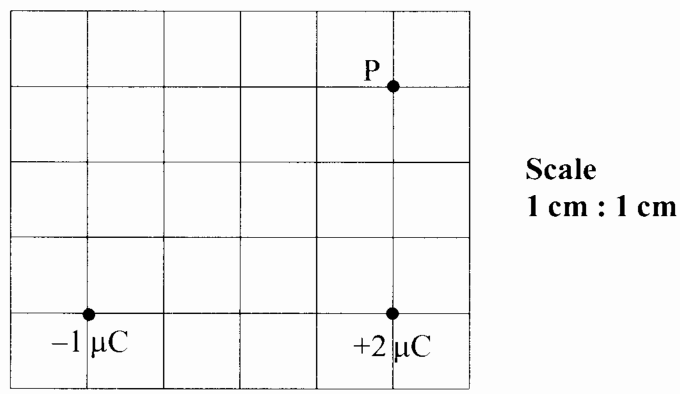
(1)

(b) Figure 1 is drawn to scale. It shows two point charges of –1 μC and +2 μC and a point P.

Figure 1



(i) By using measurements from Figure 1, calculate the electric field strength due to each charge at P.

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....

Electric field strength due to the –1 μC charge = ...

Electric field strength due to the +2 μC charge = ...

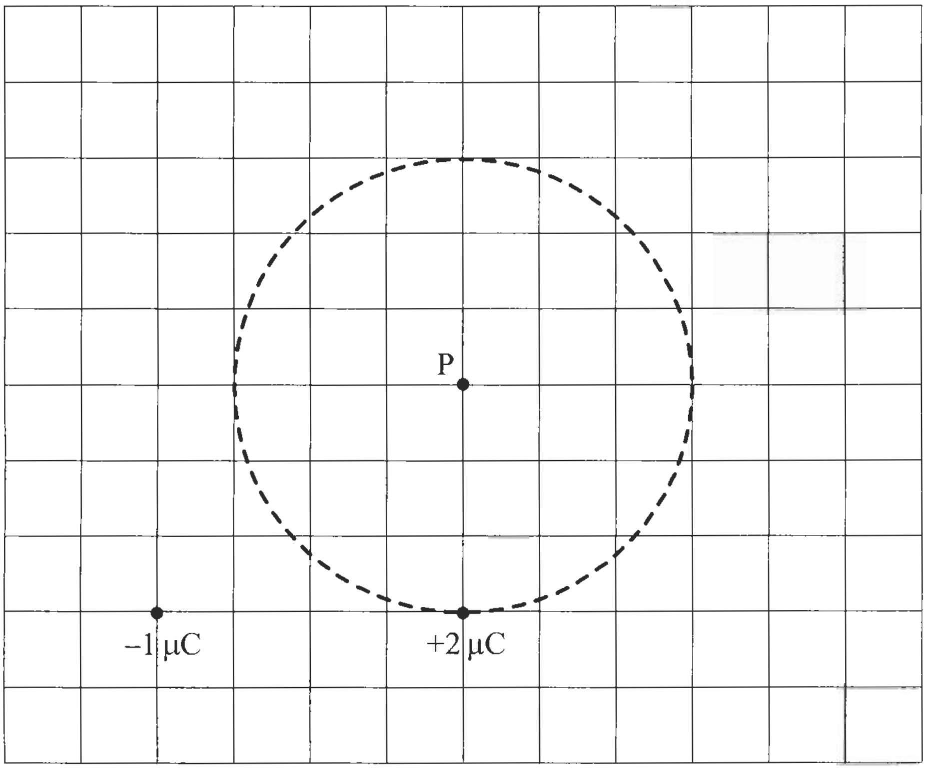
(3)

(ii) Add arrows to Figure 1 at the point P to show the direction of each of these electric field strengths.

(1)

(c) The +2 μC charge is now moved around in a circle centred about P as shown in Figure 2. The –1 μC charge does not move.

Figure 2



The resultant electric field strength at P will vary as the +2 μC charge travels around the circle.

(i) Show on Figure 2 how to locate the positions of the +2 μC charge that will give the maximum and the minimum values of the resultant electric field strength at P.

(ii) On Figure 2, carefully label these positions MAX and MIN.

(2)

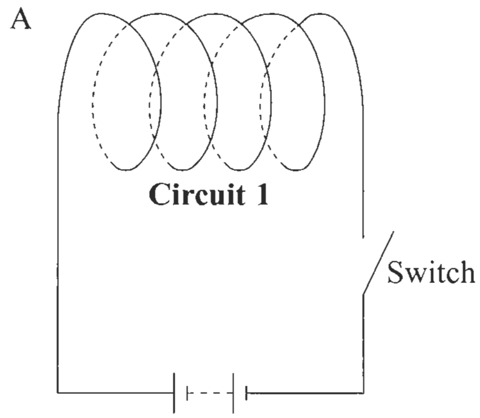
(Total 7 marks)

Leave blank

Q3

4. Figure 1 shows a circuit which consists of a coil, a battery and a switch. This is **Circuit 1**.

Figure 1

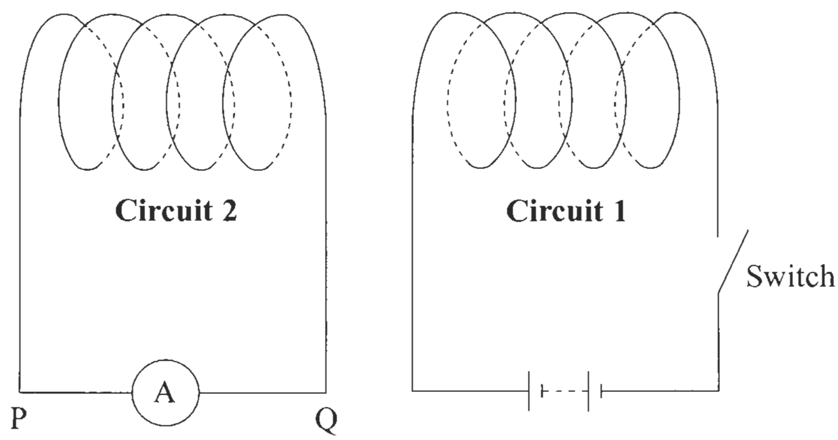


(a) On Figure 1 above, mark the direction of the magnetic field produced at the end A of the coil when the switch is closed.

(1)

(b) A second circuit, **Circuit 2**, is now placed close to **Circuit 1** as shown in Figure 2.

Figure 2



As the switch is closed in **Circuit 1**, there is a momentary current in **Circuit 2**.

Leave blank

(i) Explain why there is a momentary current in **Circuit 2**. You may be awarded a mark for the clarity of your answer.

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(5)

(ii) Explain why the current's direction is from Q to P through the ammeter.

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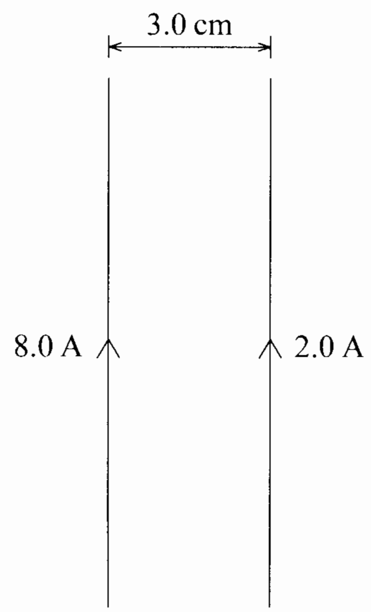
(2)

Q4

(Total 8 marks)

5. Figure 1 shows two vertical wires separated by a distance of 3.0 cm. Each carries a current of the value shown.

Figure 1



(a) (i) State the direction of the magnetic field produced by each current at a point midway between the wires.

Direction for 8.0 A = ...

Direction for 2.0 A = ...

(1)

(ii) Calculate the magnitude of the resultant magnetic field at a point midway between the wires.

....

....

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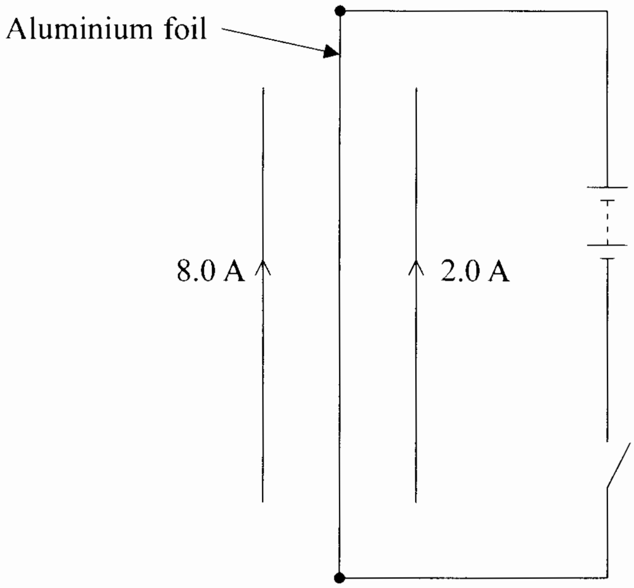
Resultant magnetic field = ...

(3)

(b) Figure 2 shows a strip of aluminium foil supported midway between the wires. It is connected into a circuit as shown.

Figure 2



Describe and explain what happens to the foil when the switch is closed.

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(3) **Q5**

(Total 7 marks)

Leave blank

6. The electron beam inside a cathode ray tube is produced by electrons which are emitted from the surface of a heated filament. They are then accelerated through a 5.0 kV accelerating potential.

(a) Explain why the filament has to be supplied with thermal energy in order for electrons to be emitted.

....

....

....

(1)

(b) (i) Calculate the final speed of an electron when it is accelerated from rest through a potential difference of 5.0 kV.

....

....

....

....

....

Final speed of electron = ...

(3)

(ii) Suggest a reason why the electrons forming the electron beam in the cathode ray tube, though accelerated through the same potential difference of 5.0 kV, do not have identical final speeds.

....

....

(1)

Q6

(Total 5 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	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$	
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 $\theta/°\text{C} = T/\text{K} - 273$

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

Capacitance

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

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

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

Time constant for capacitor to charge or 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)
	$\cos\theta \approx 1$	