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 21 January 2008 – 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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N 2 6 4 1 3 A 0 1 1 6

Turn over

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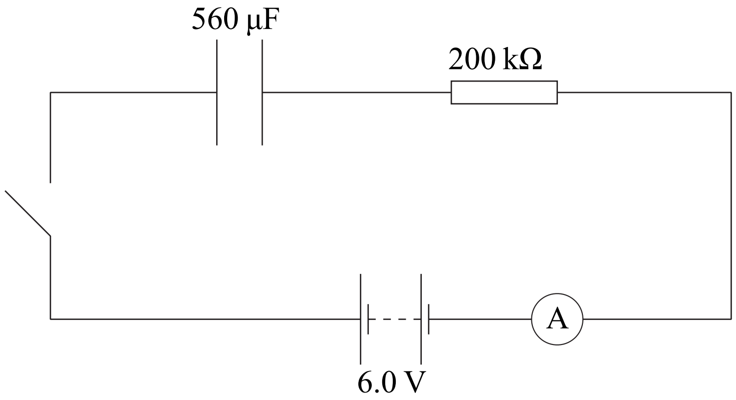
1. The diagram shows a capacitor and a resistor connected to a 6.0 V battery. Both the ammeter and the battery have negligible internal resistance.



The switch is closed. Some time later the ammeter reads 20 μA.

(a) Show that the potential difference across the capacitor at this instant is 2.0 V.

....

....

....

....

(2)

(b) Calculate the charge stored in the capacitor when the potential difference across it is 2.0 V.

....

....

Charge = ...

(2)

(c) Calculate the electrical energy now stored in the capacitor.

....

....

Electrical energy stored = ...

(1)

Leave blank

(d) Calculate the electrical energy transferred in the battery up to this instant.

....

....

Electrical energy transferred = ...

(1)

(e) What is the main reason for the difference between the energy values you have calculated in (c) and (d)?

....

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....

(1)

Q1

(Total 7 marks)

Leave blank

2. (a) A proton has a mass of 1.67×10^{-27} kg. Calculate the magnitude of the potential difference needed to accelerate it from rest to a speed of $2.77 \times 10^{5}\,\text{m s}^{-1}$ in a vacuum.

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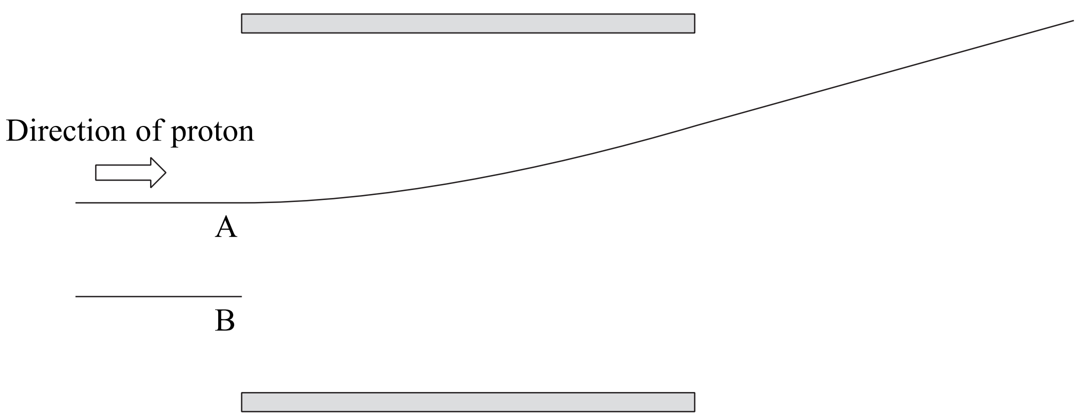
Potential difference = ...

(3)

(b) The proton now passes the point A between two parallel conducting plates across which a steady potential difference is maintained. The path of the proton is shown in the diagram.



Add to the diagram the path the same proton would have taken had it entered at the point B.

(1)

N 2 6 4 1 3 A 0 4 1 6

Leave blank

(c) (i) An alpha particle enters at point A with the same velocity as the proton. Add its path to the diagram.

(2)

(ii) Explain your answer to (c)(i).

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(2)

Q2

(Total 8 marks)

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Turn over

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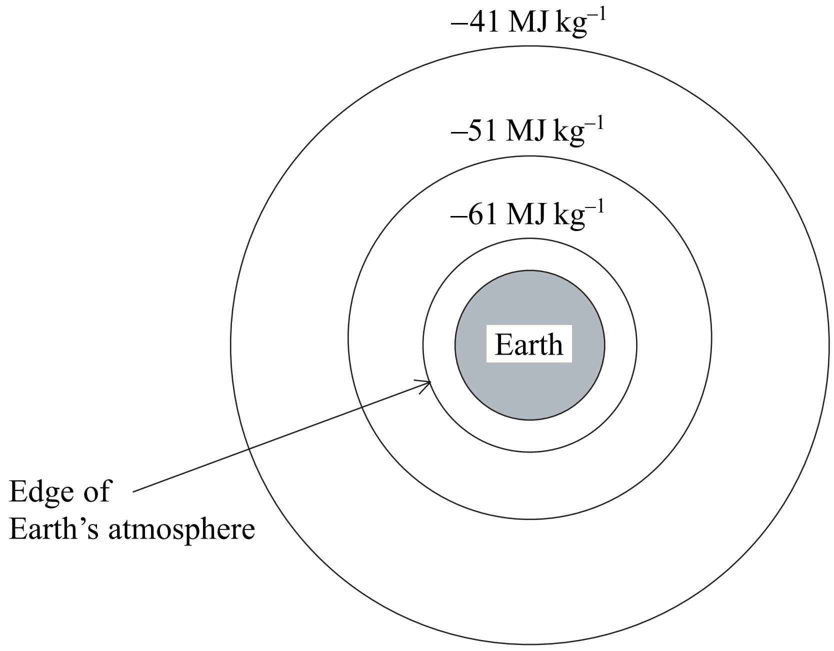
3. The diagram shows three equipotential surfaces centred about the Earth with their values marked.



(a) State **two** deductions that can be made from the diagram.

1. ....

....

2. ....

....

(2)

N 2 6 4 1 3 A 0 6 1 6

Leave blank

(b) The gravitational potential at the Moon's orbit due to the Earth alone is approximately $-1.0\ \mathrm{MJ\,kg^{-1}}$. Use this fact and information from the diagram above to show that a spacecraft, returning from the Moon's orbit using only the gravitational attraction of the Earth, would be travelling at approximately $11\ \mathrm{km\,s^{-1}}$ on arrival at the Earth's atmosphere.

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(4)

(c) There is a point between the Earth and the Moon where their gravitational attractions on a given mass are equal and opposite. Use the formula for the gravitational attraction between point masses to show that this distance is nearly 10 times further from the Earth than from the Moon.

Mass of the Earth $= 6.0 \times 10^{24}$ kg
Mass of the Moon $= 7.4 \times 10^{22}$ kg.

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(4)

Q3

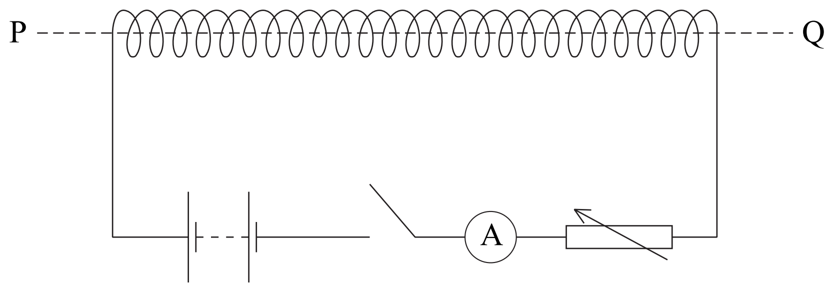
(Total 10 marks)

N 2 6 4 1 3 A 0 7 1 6

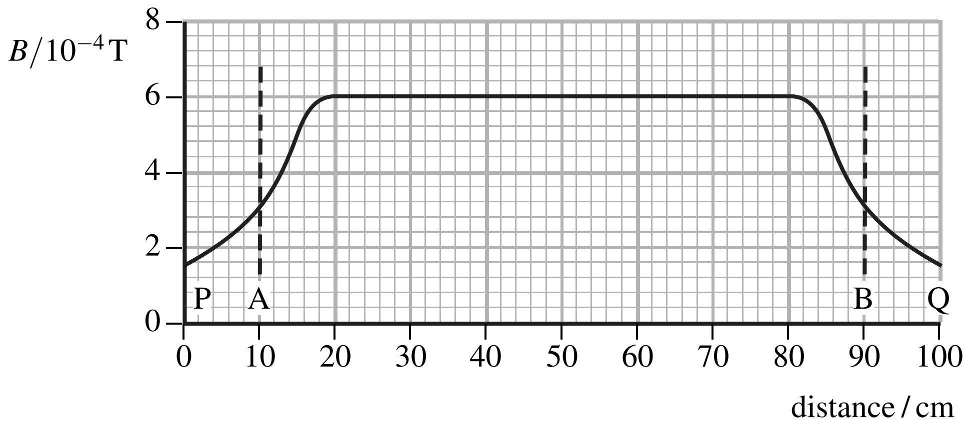
Turn over

Leave blank

4. (a) The diagram shows a long solenoid connected to a circuit. PQ is a line that passes along the axis of the solenoid.



The magnetic flux density B is investigated along the line PQ. Typical results are shown on the graph below. The distance AB represents the region inside the solenoid.



(i) Along what length of the axis of the solenoid is the field uniform?

....

(1)

(ii) Determine the magnitude of the current in the solenoid. The solenoid has 300 turns.

....

....

....

....

Current = ...

(3)

Leave blank

(b) State **one** factor that determines the direction of the magnetic field within a solenoid.

....

....

(1) **Q4**

(Total 5 marks)

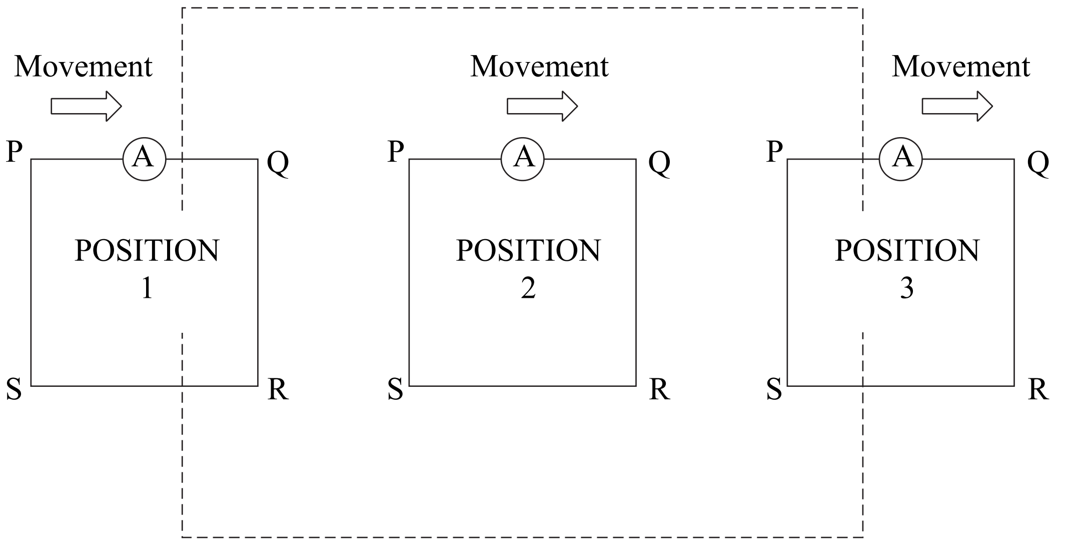
N 2 6 4 1 3 A 0 9 1 6

Turn over

Leave blank

5. A square rigid metal frame PQRS, of side 12 cm, forms a closed circuit with an ammeter.

The area enclosed by the dotted line is a region of uniform magnetic field of flux density 2.0×10^{-2} T. The field is confined to this area and directed into the page.



(a) The frame is moved at a constant speed of $5.0\ \text{cm s}^{-1}$ through the uniform magnetic field region as shown in the diagram.

(i) For each position of the frame shown in the diagram either give the direction of the current through the ammeter, or if there is no current, state 'no current'.

Position 1= ....

Position 2 = ...

Position 3 = ...

(2)

N 2 6 4 1 3 A 0 1 0 1 6

Leave blank

(ii) The total electrical resistance of the frame and ammeter is 2.0 Ω. Calculate the maximum current recorded by the ammeter.

....

....

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....

....

....

Maximum current = ...

(4)

(b) The frame is now moved with uniform acceleration through the magnetic field. Explain how the magnitude of the current changes as the frame moves from position 1, through position 2 to position 3. You may be awarded a mark for the clarity of your answer.

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(4)

Q5

(Total 10 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	$V = \varepsilon - Ir$	(E.m.f. ε; Internal resistance r)
Circuit e.m.f.	$\Sigma\varepsilon = \Sigma IR$	
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	$= 2\pi fx_0$	
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 $I = \dfrac{P}{4\pi r^2}$ (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 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	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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