| 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 16 June 2005 – Morning

Time: 1 hour

Examiner's use only

Team Leader's use only

| Question Number | Leave Blank |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| Total | |

**Materials required for examination**
Nil

**Items included with question papers**
Nil

### 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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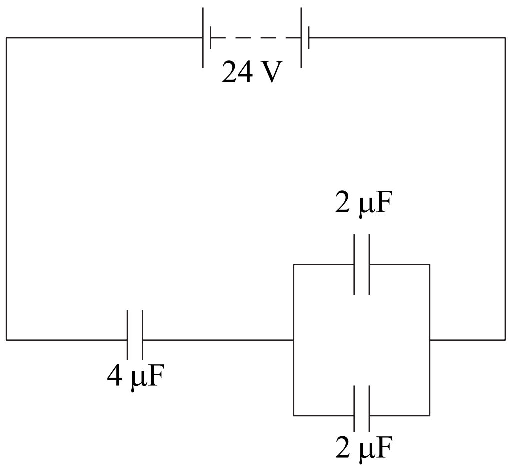
**1.** The circuit below shows three capacitors connected to a 24 V battery.




(i) Calculate the equivalent capacitance of the two capacitors connected in parallel.

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Capacitance = ....................................

**(1)**

(ii) Hence calculate the charge stored by the 4 μF capacitor.

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Charge = ..........................................

**(3)**

**Q1**

**(Total 4 marks)**



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**2.** (a) (i) State Newton's law for the gravitational force between point masses.

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**(2)**

(ii) Use this law to show that the gravitational field strength $g$ at a distance $r$ from the centre of the Earth, where $r$ is greater than or equal to the radius $R$ of the Earth, is given by

$$g = \frac{GM}{r^2}$$

where $M$ is the mass of the Earth.

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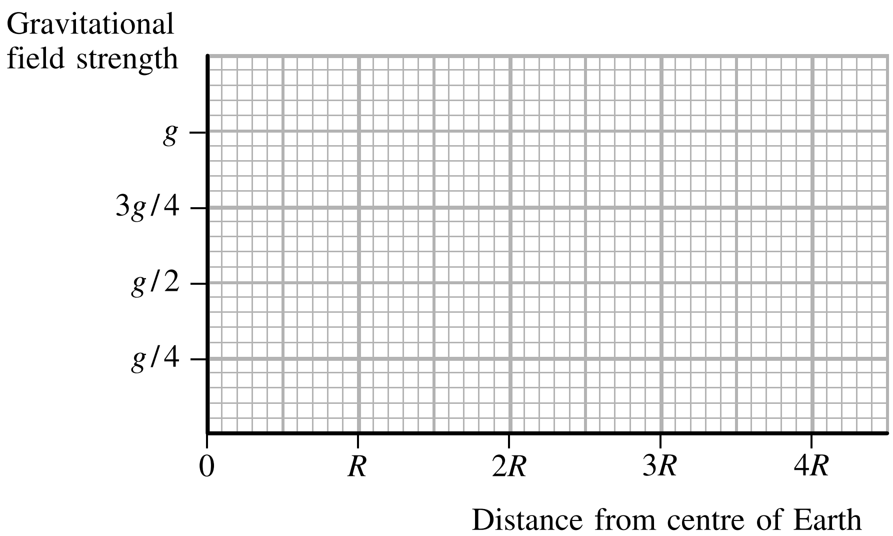
**(1)**

(iii) Use the axes below to plot a graph to show how $g$ varies as the distance $r$ increases from its minimum value of $R$ to a value of $4R$.




**(3)**

(b) (i) When a satellite, which travels in a circular orbit around the Earth, moves to a different orbit the change in its gravitational potential energy can be calculated using the idea of equipotential surfaces. What is an equipotential surface?

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**(1)**

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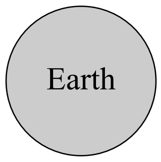
(ii) Add to the diagram below three equipotential surfaces which have equal changes of potential between them.




**(2)**

(c) The change in the gravitational potential energy of the satellite when it moves to a different orbit might be calculated using the expression

'weight of satellite × change in height'.

(i) What condition must apply for this to be valid?

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(ii) Explain your answer.

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**(2)**

**Q2**

**(Total 11 marks)**

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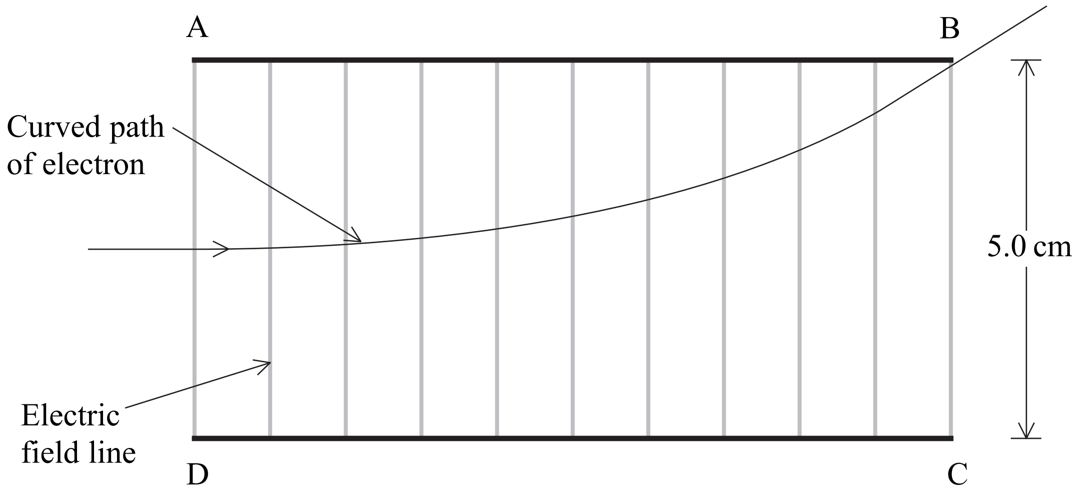
**3.** The diagram shows the path of an electron in a uniform electric field between two parallel conducting plates AB and CD. The electron enters the field at a point midway between A and D. It leaves the field at B.




(a) Mark on the diagram the direction of the electric field lines.

**(1)**

(b) (i) The conducting plates are 5.0 cm apart and have a potential difference of 250 V between them. Calculate the force on the electron due to the electric field.

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Force = ...............................................

**(3)**

(ii) State the direction of this force on the electron and explain why it does not affect the horizontal velocity of the electron.

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**(2)**

Leave blank

(c) To leave the electric field at B the electron must enter the field with a speed of $1.30 \times 10^7\,\mathrm{m\,s^{-1}}$. Calculate the potential difference required to accelerate an electron from rest to this speed.

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Potential difference = .........................

**(3)**

(d) A very thin beam of electrons enters a uniform electric field at right angles to the field. The electrons have a range of speeds.

(i) Draw a diagram to show the shape of the beam as it moves through the field.

(ii) On your diagram label which electrons have the fastest speed.

**(2)**

**Q3**

**(Total 11 marks)**

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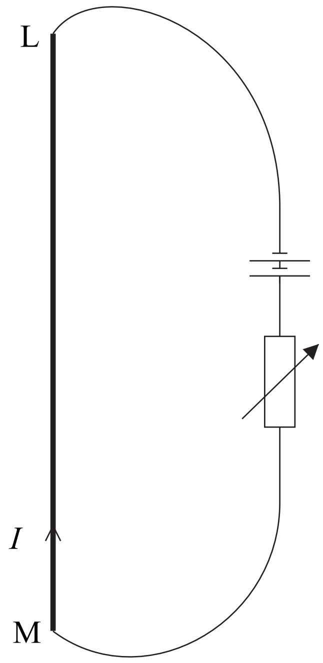
**4.** (a) The circuit diagram shows a long straight wire LM carrying a current $I$ in the direction shown.




Describe how you would investigate the variation of magnetic flux density $B$ with perpendicular distance $r$ from LM in a region around the centre of the wire. You may add to the above diagram if you wish.

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**(4)**

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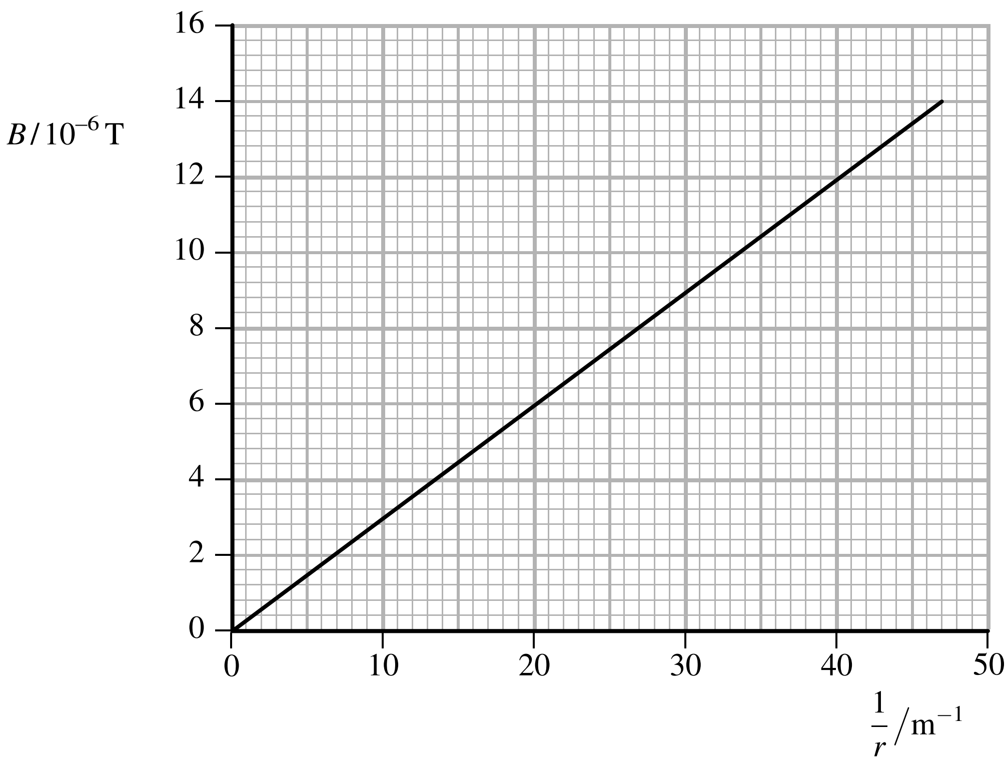
(b) A typical graph of $B$ against $\frac{1}{r}$ for a straight wire carrying a current $I$ is shown below.




(i) Describe the relationship between $B$ and $r$ shown by the graph.

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**(1)**

(ii) Use the graph to determine the value of the current $I$ in the wire.

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Current = ..........................................

**(3)**

**Q4**

**(Total 8 marks)**

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**5.** Explain the action of a step-down transformer. Your explanation should include reference to the parts played by the primary and secondary coils and the core of the transformer. You may be awarded a mark for the clarity of your answer.

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**Q5**

**(Total 6 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 $\lambda$)

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 $\Delta T$)

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 $\Delta Q$; Work done on body $\Delta W$)

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 $\lambda$; 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 $\varphi$)

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 $\mu_0$) |
| 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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