Centre No.						Paper Reference	Surname	Initial(s)
Candidate No.						6 7 3 4 / 0 1	Signature	

Paper Reference(s)

6734/01

Edexcel GCE

Physics

Advanced Level

Unit Test PHY4

Thursday 16 June 2005 – Morning

Time: 1 hour 20 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
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 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.
There are eight questions in this paper. The total mark for this paper is 60.
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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Turn over

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1. (a) Explain why a body moving at constant speed in a circular path needs a resultant force acting on it.

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....

....

....
(2)

(b) (i) A girl standing at the equator is in circular motion about the Earth's axis. Calculate the angular speed of the girl.

....

....

....

Angular speed = ...
(2)

(ii) The radius of the Earth is 6400 km. The girl has a mass of 60 kg. Calculate the resultant force on the girl necessary for this circular motion.

....

....

Force = ...
(2)

(iii) If the girl were to stand on weighing scales calibrated in newtons, what reading would they give?

....

....

....

Scale reading = ...
(3)

Q1

(Total 9 marks)

Leave blank

2. The table below summarises some features of the electromagnetic spectrum. Complete the table by filling in the missing types of radiation, wavelengths and sources.

Radiation	Typical wavelength	Source
Visible light		Very hot objects
Gamma		
	100 m	High frequency electrical oscillator
	10^{-6} m	

Q2

(Total 6 marks)

N 2 0 8 6 0 A 0 3 1 6

Turn over

Leave blank

3. (a) A 100 W ceiling light bulb is 2.5 m above the floor. It is 6.0% efficient at converting electrical energy to visible light. Calculate the visible light intensity at the floor directly beneath the bulb.

....

....

....

....

Intensity = ...

(3)

(b) The number of photons hitting a square metre in one second at this distance from the bulb is 2.4×10^{17}. Find the average energy of the photons in electronvolts.

....

....

....

....

....

Average energy of photons = ...

(3)

Q3

(Total 6 marks)

4. A stationary wave of amplitude 4.0 cm is produced by the superposition of two progressive waves that travel in opposite directions.

(a) Define the term **amplitude**.

....

....
(1)

(b) The graph below shows the positions of the stationary wave and of one of the two progressive waves at a particular instant. Apply the principle of superposition to determine the displacement of the other progressive wave at positions A, B and C on the distance axis at this same instant.

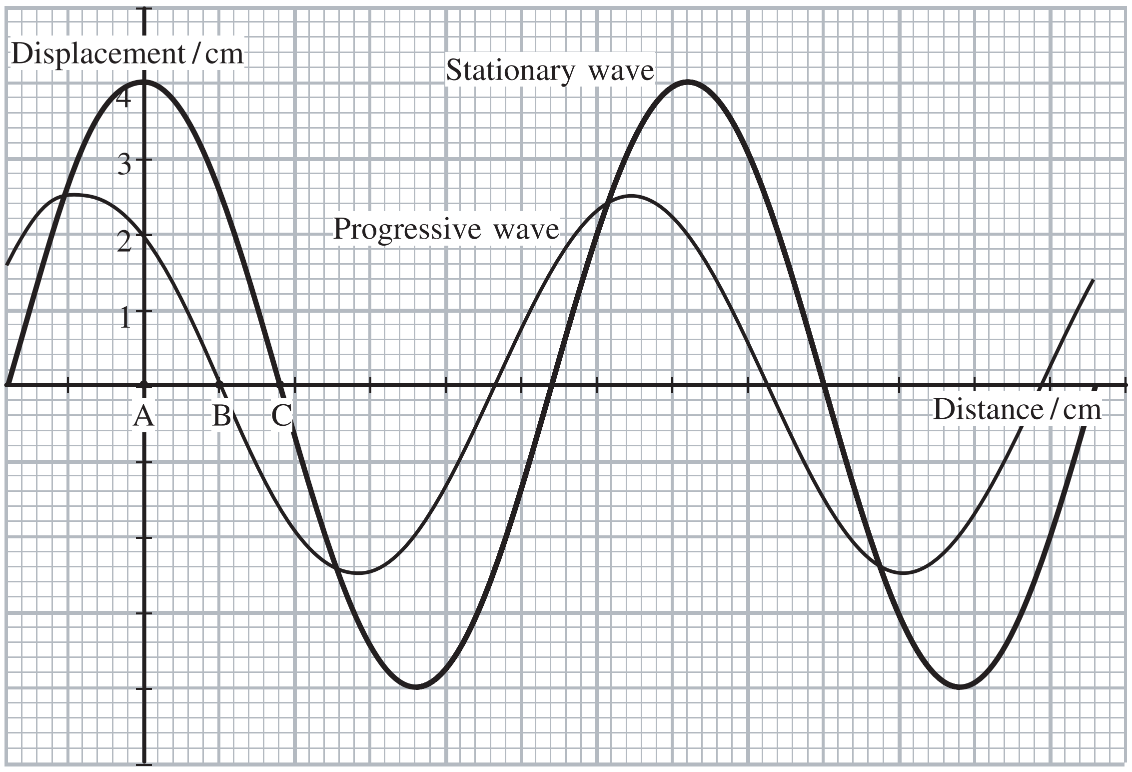
Displacement at A ....

Displacement at B ....

Displacement at C ....
(3)

Plot these displacement values on the graph.

Hence draw one complete wavelength of this progressive wave.



(3)

Q4

(Total 7 marks)

Leave blank

5. (a) Explain what is meant by the term **transverse wave**. You may wish to illustrate your answer with the help of a simple diagram.

....

....

....
(3)

(b) State two differences between a stationary wave and a progressive wave.

Difference 1 ....

....

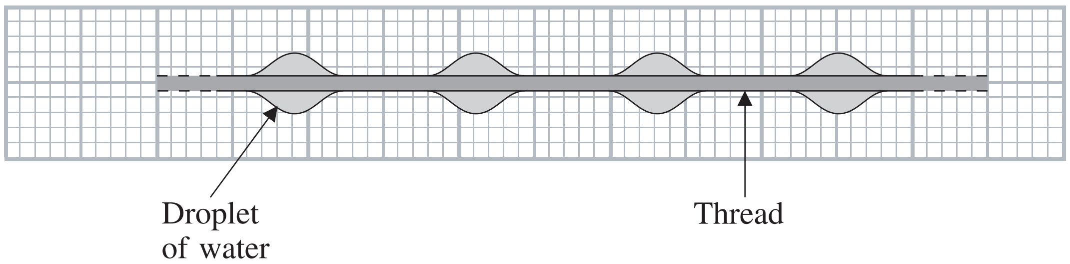
Difference 2 ....

....
(2)

Leave blank

(c) Spiders are almost completely dependent on vibrations transmitted through their webs for receiving information about the location of their prey. The threads of the web are under tension. When the threads are disturbed by trapped prey, progressive transverse waves are transmitted along the sections of thread and stationary waves are formed.

Early in the morning droplets of moisture are seen evenly spaced along the thread when prey has been trapped.



1 cm on diagram represents 0.25 cm of thread

(i) Explain why droplets form only at these points.

....

....

(1)

(ii) The speed of a progressive transverse wave sent by trapped prey along a thread is 9.8 cm s^{-1}. Use the diagram to help you determine the frequency of the stationary wave.

....

....

....

....

Frequency = ...

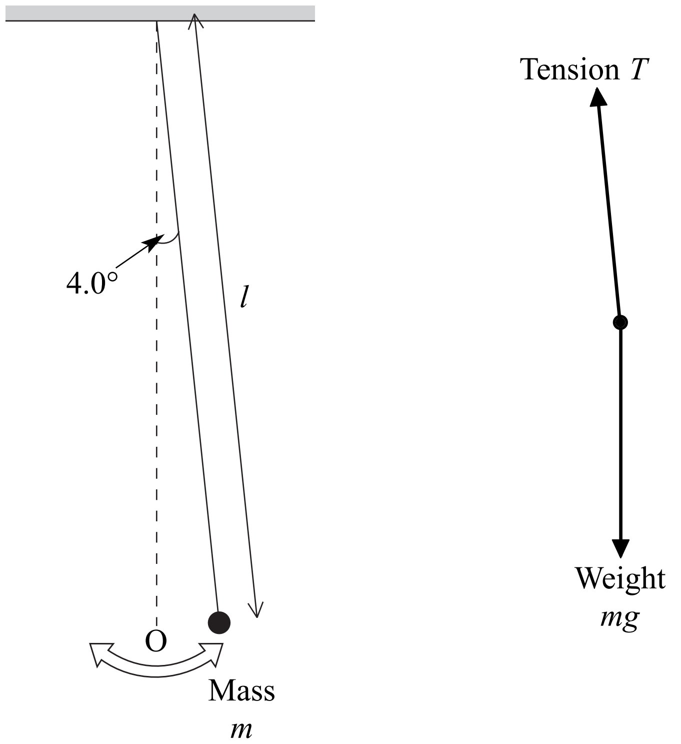
(4)

Q5

(Total 10 marks)

Leave blank

6. A simple pendulum of length *l* consists of a small mass *m* attached to the end of a thread. The other end is fixed. The mass is slightly displaced through an angle of 4.0° and then released so that it oscillates along a small arc with centre O.



(a) The free-body force diagram for the oscillating mass at its maximum displacement is drawn alongside.

(i) Add to the free-body force diagram the component of weight that is equal in magnitude to the tension *T* at this instant. Label it A.

(1)

(ii) Add to the same diagram the component of weight that acts perpendicularly to the line of action of the tension. Label it B.

(1)

(iii) Determine the magnitude of the instantaneous acceleration of the mass.

....

....

Acceleration = ...

(2)

(iv) State the direction of this acceleration.

....

(1)

N 2 0 8 6 0 A 0 8 1 6

Leave blank

(b) The period of the pendulum is 4.2 s. When the length l is shortened by 1.0 m the period becomes 3.7 s. Show how this data can be used to determine a value for the acceleration of free fall. You should obtain an appropriate equation and substitute the data, but you are not expected to perform the final calculation.

....

....

....

....

....

....

(3)

Q6

(Total 8 marks)

Leave blank

7. (a) What is meant by the Doppler effect (electromagnetic Doppler effect) when applied to light?

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....

....
(2)

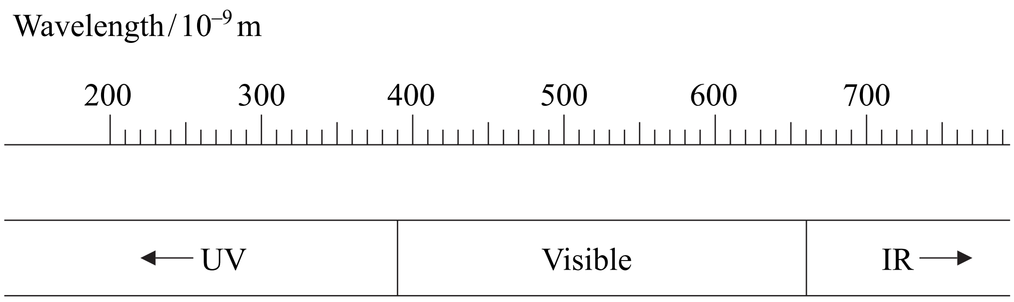
(b) Edwin Hubble reached a number of conclusions as a result of observations and measurements of red-shift. State two of these conclusions.

....

....

....
(2)

(c) The diagram gives values of wavelength for part of the electromagnetic spectrum.



A very hot distant galaxy emits violet light just at the edge of the visible spectrum. Estimate the maximum velocity the galaxy could have so that visible light could still be detected as it moves away from the Earth.

....

....

....

....
(4)

Leave blank

(d) The fate of the Universe is dependent on the average mass-energy density of the Universe. What is meant by the critical density of the Universe?

....

....

....

(2)

Q7

(Total 10 marks)

Leave blank

8. The photoelectric effect supports a particle theory of light but not a wave theory of light.

Below are two features of the photoelectric effect. For each feature explain why it supports the particle theory and not the wave theory.

(a) Feature 1: The emission of photoelectrons from a metal surface can take place instantaneously.

Explanation ....

....

....

....

....

....

(2)

(b) Feature 2: Incident light with a frequency below a certain threshold frequency cannot release electrons from a metal surface.

Explanation ....

....

....

....

....

....

(2)

Q8

(Total 4 marks)

TOTAL FOR PAPER: 60 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	$1\ \mathrm{eV} = 1.60 \times 10^{-19}\ \mathrm{J}$	
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	$P = I^2R$	

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	$\theta/°\mathrm{C} = T/\mathrm{K} - 273$	

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 $= 2\pi fx_0$

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

$$\sin(90^\circ - \theta) = \cos\theta$$

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

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

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)
	$\cos\theta \approx 1$	