Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	7	5	4	/	0	1	Signature	

Paper Reference(s)

6754/01

Edexcel GCE

Salters Horners Physics

Advanced Level

Unit Test PSA4

Thursday 14 June 2007 – Morning

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
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** of the questions, writing your answers in this question booklet.
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 mark for individual questions and the parts of questions are shown in round brackets.
There are seven 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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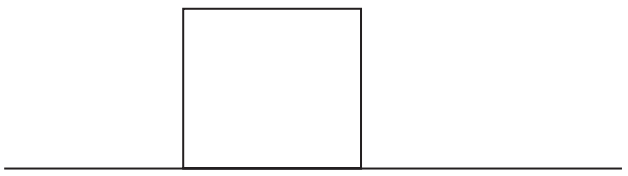
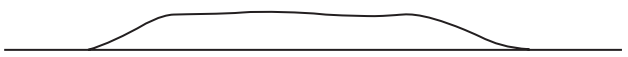
1. The diagrams show a pulse of light before it enters a length of optical fibre and as it leaves the fibre.



Input



Output

(i) Describe the change in the pulse caused by attenuation.

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(1)

(ii) Describe the change in the pulse caused by dispersion.

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(1)

(iii) State how attenuation occurs.

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(1)

(iv) Describe how the length of the fibre affects the intensity of the pulse.

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(1)

Leave blank

(v) Explain why dispersion occurs in terms of rays of light travelling down the fibre. You should add to the diagram of an optical fibre below as part of your answer.

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(4)

(vi) Explain how the length of the fibre affects the amount of dispersion.

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(1)

(vii) Describe one method for reducing dispersion and explain how it works.

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(3)

Q1

(Total 12 marks)

Leave blank

2. Below are some extracts from the novel "Angels and Demons" by Dan Brown. A discussion about antimatter is taking place between two characters.

(a) Extract 1

A: "So antimatter is real?"

B: "A fact of nature. Everything has its opposite. **Protons have electrons. Up quarks have down quarks.** There is a cosmic symmetry at the subatomic level."

In the context of antimatter, comment on the scientific accuracy of the two statements in bold type.

Protons have electrons. .....

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Up quarks have down quarks. .....

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(5)

(b) Extract 2

A: "There would be no way to separate the particles from their antiparticles."

B: "He applied a magnetic field. Matter arced right, and antimatter arced left."

Comment on the physics of this method for separating particles from their antiparticles.

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(2)

Leave blank

(c) Extract 3

A: "You collected visible amounts of antimatter?"

B: "Five thousand nanograms ... a plasma containing millions of positrons."

Calculate how many positrons there would be in a sample of five thousand nanograms.

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Number of positrons = ...

(1)

(d) Extract 4

B: "Antimatter releases pure energy. A one hundred per cent conversion of mass to photons. **So don't look directly at the sample. Shield your eyes.**"

(i) A positron annihilates with an electron to produce two identical photons. Calculate the wavelength of each photon.

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Wavelength = ...

(3)

(ii) Comment on the two sentences in bold type in relation to the wavelength you have calculated.

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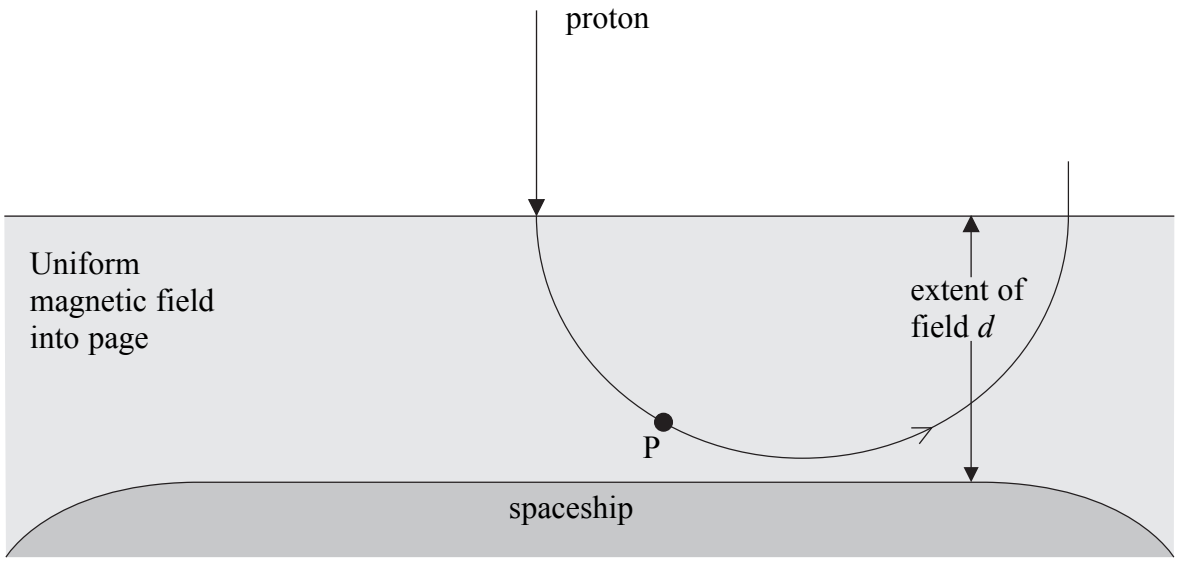
(1)

Q2

(Total 12 marks)

Leave blank

3. One of the hazards of long flights in space for humans will be exposure to radiation, particularly high energy protons from the Sun travelling as part of the 'solar wind'. Magnetic shielding could reduce the radiation reaching the crew. A strong magnetic field would be established around the outside of the spaceship. This field would then deflect the protons. The path of a proton which just misses the spaceship is shown.



(a) (i) Draw an arrow on the diagram to show the direction of the force on the proton at point P.

(1)

(ii) Calculate the force on a proton entering the field as shown in the diagram with a speed of 800 km s^{-1}. Magnetic flux density = 0.50 T.

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Force = ...

(2)

(iii) Calculate the minimum value of *d*, the extent of this field, needed to prevent protons of this speed from striking the spaceship.

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d = ...

(2)

Leave blank

(iv) Calculate the time this proton spends in the field.

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Time = ...

(2)

(v) Calculate the average resultant force exerted on the proton during this process of reversing its direction of travel.

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Force = ...

(3)

(b) An alternative proposal is to maintain a positive charge on a spaceship to repel protons. To repel protons travelling at 800 km s^{-1} would require a spherical ship of 5 m radius to carry a charge of 1.9 μC.

Calculate the force exerted by this positive charge on a proton close to the surface of this spaceship. Assume that this charge acts as though it is concentrated at the centre of the ship.

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Force = ...

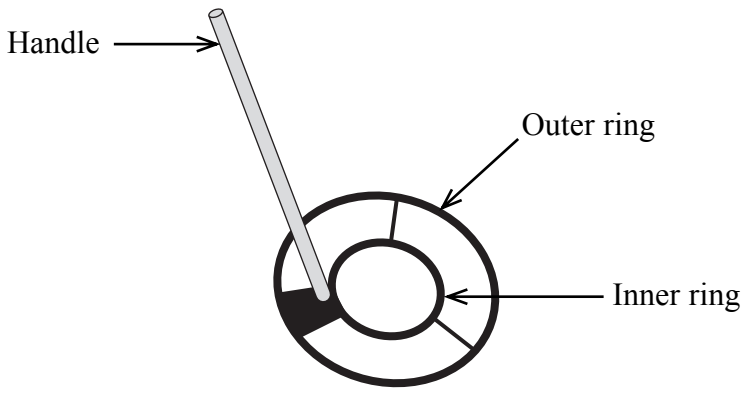
(2)

Q3

(Total 12 marks)

Leave blank

4. The diagram shows the bottom part of a hand-held metal detector.



The outer ring contains the transmitter coil. Alternating current is passed through this coil. This creates a magnetic field which penetrates into the ground.

If the magnetic field encounters a metal object, **a current is induced in the object**. This current generates a magnetic field of its own. **The direction of the object's magnetic field is opposite to the direction of the transmitter coil's magnetic field.**

The inner ring is able to detect varying magnetic fields coming from objects in the ground.

(i) Explain why **a current is induced in the object**.

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(3)

(ii) Explain why **the direction of the object's magnetic field is opposite to the direction of the transmitter coil's magnetic field**.

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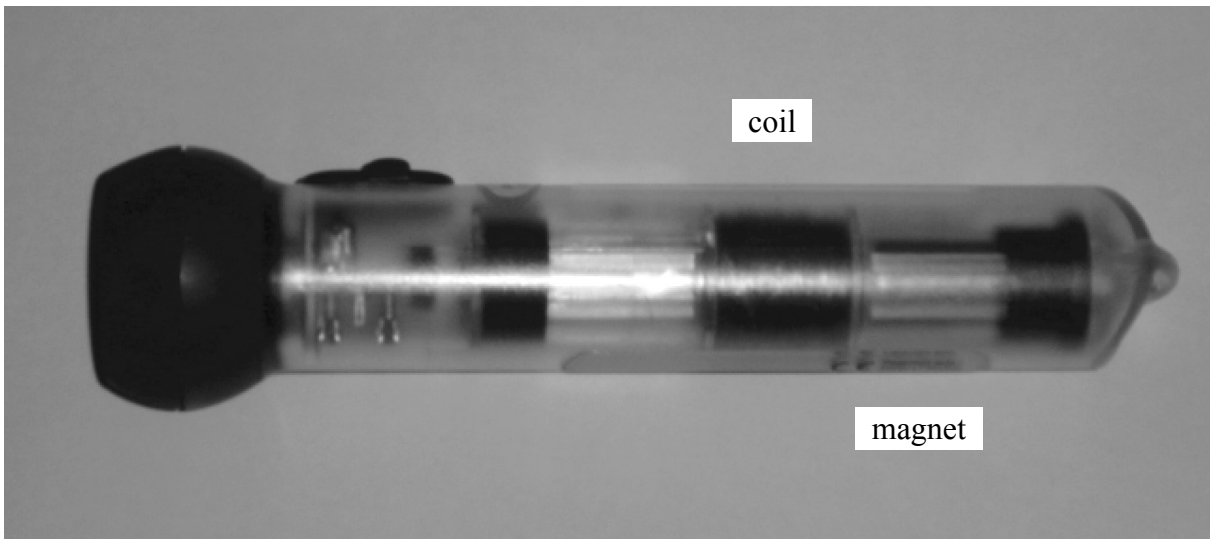
(1)

Q4

(Total 4 marks)

Leave blank

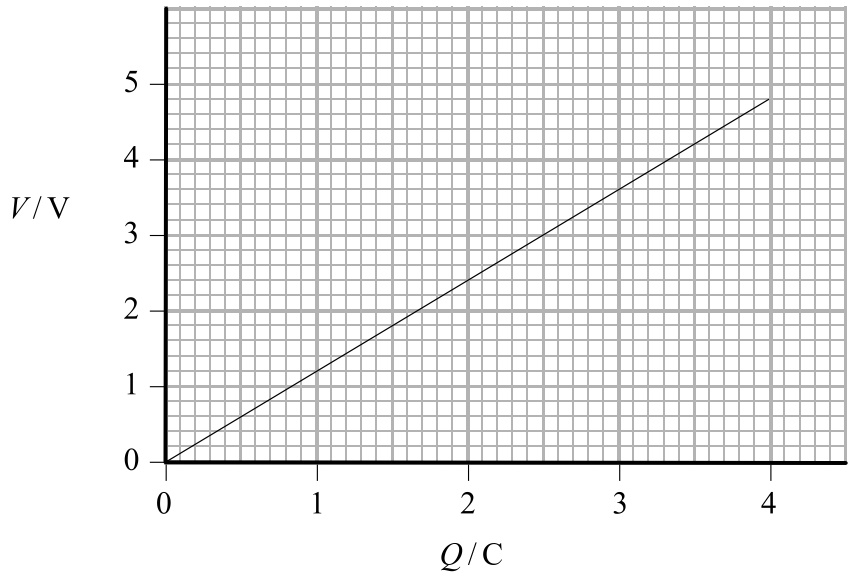
5. The photograph shows an ‘everlasting torch’ – so called because it operates without batteries.



When the torch is shaken, the strong permanent magnet moves through the coil of copper wire, generating an electric current.

Energy is stored by a capacitor. This then acts as the energy source for an LED.

(a) The following graph shows how the voltage of the capacitor varies with the charge on the capacitor.



Leave blank

(i) Calculate a value for the capacitance of the capacitor.

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Capacitance = ...

(2)

(ii) Use the graph to derive the expression $W = \frac{1}{2}QV$ for the energy stored by a capacitor.

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(3)

(iii) Calculate the energy stored by the capacitor when the voltage across it is 4.0 V.

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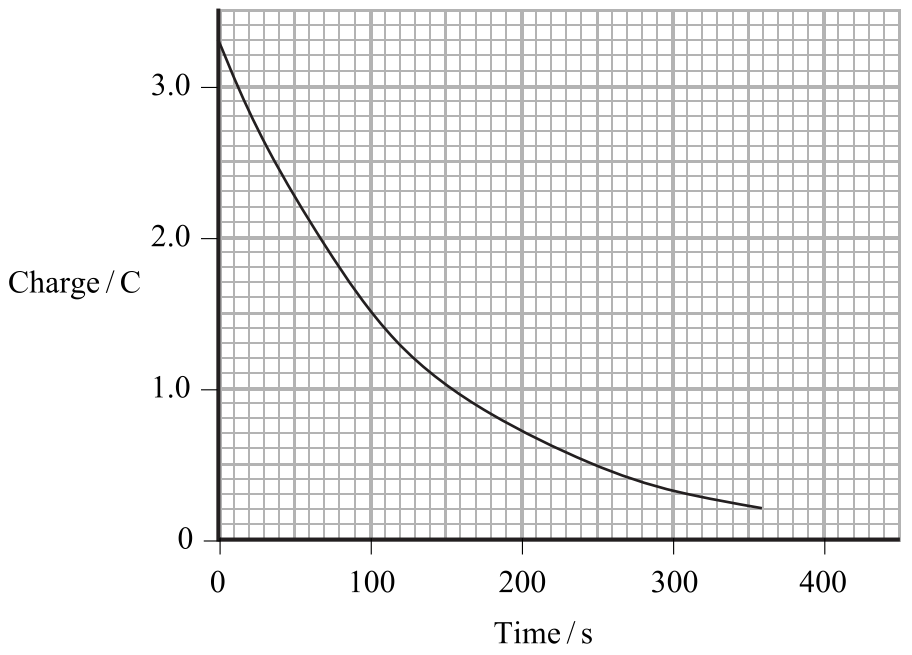
Energy = ...

(2)

Leave blank

(b) The graph shows how the charge on the capacitor varies with time when the torch is in use.



(i) Explain why the output power from the LED decreases with time.

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(2)

(ii) Use the graph to determine the time constant for the capacitor-LED circuit.

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Time constant = ...

(1)

Q5

(Total 10 marks)

Leave blank

6. Explain the role of magnetic fields in particle accelerators and detectors.

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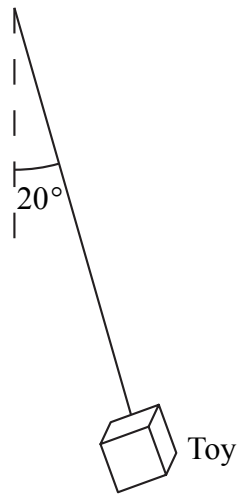
Q6

(Total 5 marks)

Leave blank

7. A small fluffy toy hangs on a string in the rear window of a car. As the car travels round a bend at 30 m s^{-1} the string hangs sideways at an angle of 20° to the vertical.

(i) Mark on the diagram the forces acting on the toy.



(ii) Calculate the radius of the curve in the road.

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Radius = ... **Q7**

(Total 5 marks)

TOTAL FOR PAPER: 60 MARKS

END

List of data, formulae and relationships

Data

Gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$	
Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to Earth's surface)
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)
Electronic charge	$e = -1.60 \times 10^{-19}\ \text{C}$	
Electronic mass	$m_e = 9.11 \times 10^{-31}\ \text{kg}$	
Electronvolt	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$	
Proton mass	$m_p = 1.67 \times 10^{-27}\ \text{kg}$	
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$	
Molar gas constant	$R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$	
Boltzmann constant	$k = 1.38 \times 10^{-23}\ \text{J K}^{-1}$	
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$	
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\ \text{N A}^{-2}$	

Unit 1

Physics at work, rest and play

Mechanics

Kinematic equations of motion $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

Energy

% *efficiency* = [*useful energy* (or power) *output/total energy* (or power) *input*] × 100%

Heating $\Delta E = mc\Delta\theta$

Quantum Phenomena

Photon model $E = hf$

Waves and Oscillations

For waves on a wire or string $v = \sqrt{(T/\mu)}$

For a lens $P = 1/f$

Unit 2

Physics for life

Quantum Phenomena

Photoelectric effect	$hf = \phi + \frac{1}{2}mv_{\max}^2$

Materials

Elastic strain energy	$\Delta E_{\text{el}} = F\Delta x/2$
Stress	$\sigma = F/A$
Strain	$\varepsilon = \Delta x/x$
Young modulus	$E = \sigma/\varepsilon$
Stokes' law	$F = 6\pi\eta r v$

Waves and Oscillations

Refraction	$\mu = \sin i / \sin r = v_1/v_2$
For lenses	$P = P_1 + P_2$
	$1/u + 1/v = 1/f$

Mathematics

Volume of sphere	$V = \frac{4}{3}\pi r^3$

Unit 4

Moving with physics

Mechanics

Motion in a circle	$v = \omega r$
	$T = 2\pi/\omega$

Energy

Attenuation	$I = I_0 \mathrm{e}^{-\mu x}$

Nuclear Physics

Mass-energy	$\Delta E = c^2 \Delta m$

Quantum Phenomena

de Broglie wavelength	$\lambda = h/p$

Fields

Electric field	$E = F/Q$
	$E = V/d$
In a magnetic field	$F = BIl\sin\theta$
	$F = Bqv\sin\theta$
	$r = p/BQ$
Energy stored in capacitor	$W = \frac{1}{2}QV$
Capacitor discharge	$Q = Q_0 \mathrm{e}^{-t/RC}$

Magnetic Effects of Currents

Faraday's and Lenz's Laws	$E = -\mathrm{d}(N\Phi)/\mathrm{d}t$

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