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

Monday 22 January 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	
Total	

Materials required for examination	**Items included with question papers**
Protractor	Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Answer **ALL** the questions. Write your answers 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 6 questions in this question 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, including your use of grammar, punctuation and spelling.

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1. A student researching capacitance finds the following statements in different sources:

"A human body charged to 30 000 V has only about 0.045 J of stored electrical energy."

"The human body can be modelled as a capacitor of about 10 pF in parallel with a resistor."

(a) (i) Determine whether the data given in the **first** statement are consistent with the capacitance quoted in the **second** statement.

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(3)

(ii) Calculate the static charge on the body referred to in the **first** statement.

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Charge = ...

(2)

Leave blank

(b) (i) A spark is seen when a person charged to 30 000 V brings his hand towards an earthed metal plate. Such sparks occur when the electric field strength is sufficient to ionise the air. The minimum electric field strength for this is $3.0 \times 10^6\,\mathrm{V\,m^{-1}}$. Assume that the hand and the metal plate can be treated as a pair of parallel plates, and that the voltage between the hand and the earth remains 30 000 V. Calculate the greatest separation of hand and plate for which the spark could occur.

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....

Greatest separation = ...

(2)

(ii) Ions and electrons produced in the electric field between the hand and the plate ($3.0 \times 10^6\,\mathrm{V\,m^{-1}}$) are accelerated and may collide with other particles, causing further ionisation.

Calculate the force on an electron in this field.

....

....

....

Force = ...

(2)

(c) The ionization energy of a typical particle in the air is 35 eV. Calculate the maximum number of such particles an electron could ionise while it is moving a total distance of 1 mm in this field.

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....

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Number = ...

(3)

Q1

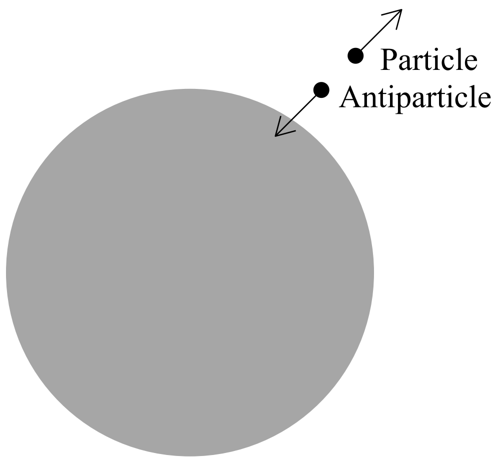
(Total 12 marks)

Leave blank

2. Black holes are formed when stars collapse into a state of extremely high density. The gravitational field strength is so great that nothing can escape from within the black hole – not even light.

Even so, Professor Stephen Hawking suggested a way in which black holes might 'evaporate' over time.

Spontaneous production of particle-antiparticle pairs close to the black hole can enable it to lose mass. If one particle falls into the black hole and the other escapes, the mass and energy of the escaping particle are lost by the black hole.



(a) Explain why you would expect the initial motion of the particle and antiparticle to be in opposite directions at the instant at which they are produced.

....

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....
(2)

(b) In a particular event, a particle (π^+) and its antiparticle (π^-) are produced. Complete the table of their properties.

Particle name	π^+	π^-
mass	0.140 GeV/c^2	
charge	$+1.6 \times 10^{-19}$ C	
quark composition	$u\bar{d}$	

(3)

N 2 3 5 9 9 A 0 4 1 6

Leave blank

(c) Circle the word below which correctly describes a π^+ particle.

meson baryon lepton

(1)

In the event described, the π^+ escapes.

(d) State the minimum energy in eV lost by the black hole.

....

....

Minimum energy = ... eV

(2)

(e) Explain why this energy is a minimum.

....

....

(1)

(f) Calculate the minimum mass in kg lost by the black hole in this event.

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....

Mass loss = ... kg

(2)

Q2

(Total 11 marks)

3. Alex Coomber won a bronze medal in the women's bobsled at the 2002 Winter Olympics. This involved hurtling down an icy track on her sled at speeds of up to 35 m s^{-1}.

During one section of the run, her speed remained constant at 35 m s^{-1} as she slid in a straight line down a slope of 10°. Figure 1 shows the three forces acting upon her during this time. Figure 2 is the first part of a scale drawing combining these forces.

Figure 1

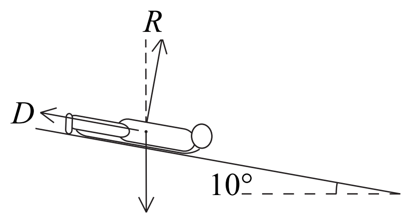
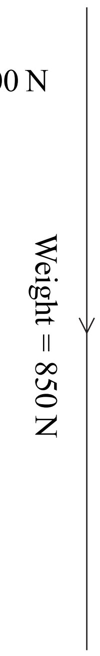


Figure 2



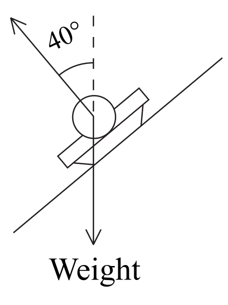
(a) Complete the scale drawing to find the size of the drag force *D*.

Drag force *D* = ...

(3)

Figure 3 shows Alex turning a corner. The banking angle is 40°. Figure 3 shows the two forces which affect her as she takes the corner at a speed of 35 m s^{-1}.

Figure 3



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N 2 3 5 9 9 A 0 6 1 6

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(b) Show that the size of P, the push on the sled from the ice, is about 1000 N.

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(2)

(c) (i) Explain why there needs to be a resultant force on Alex to take her round the corner.

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(2)

(ii) State what provides this force.

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....

(2)

(d) Calculate the radius of the corner. The combined mass of Alex and the sled is 87 kg.

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....

Radius = ...

(3)

Q3

(Total 12 marks)

Leave blank

4. Faraday's and Lenz's laws are given at the back of this paper as $E = -\mathrm{d}(N\Phi)/\mathrm{d}t$.

(a) Explain the symbol E.

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(2)

(b) Explain the significance of the minus sign.

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(2)

(c) When a car has its headlights on with the engine running, the headlights receive their power from a dynamo which is turned by the engine. A driver sits in his car with the lights off, his foot off the accelerator, and the engine running slowly. He notices that when he switches the lights on, the engine slows slightly. Explain the physics causing this effect.

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(4)

Q4

(Total 8 marks)

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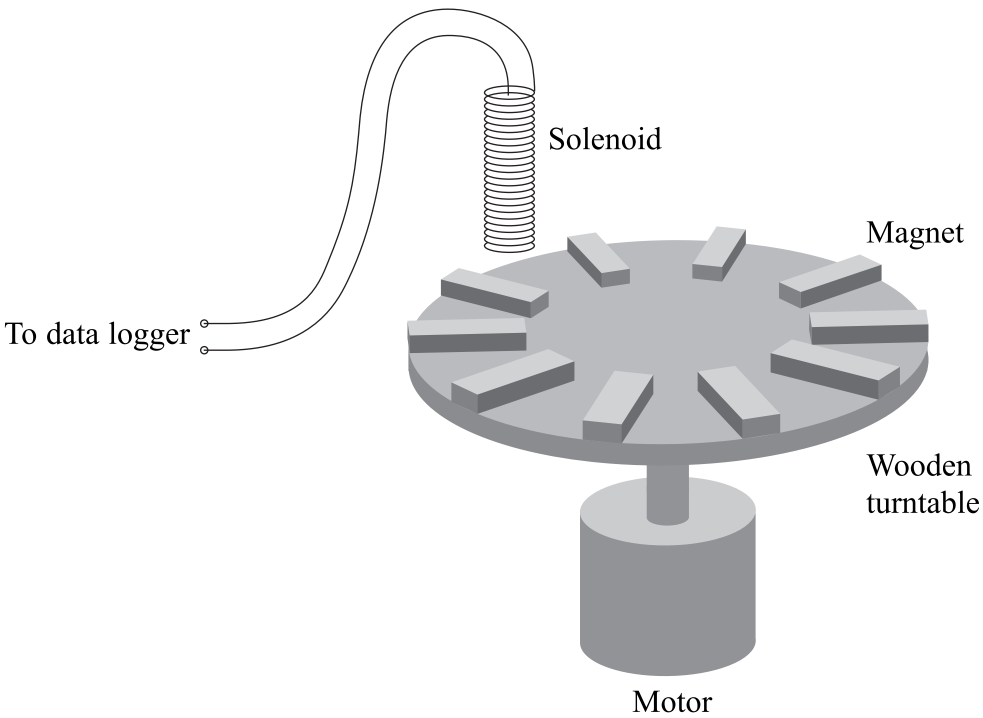
5. Most desktop computers store data on discs coated with a magnetic medium which records the data in a digital form. As a disc spins at very high speeds the magnetic field at each place on the disc can be detected in order to ‘read’ the data.

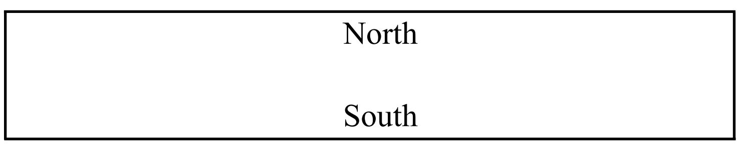
The diagram shows a school laboratory model set up to demonstrate how the system works.



The ten flat magnets on this model disc can be arranged with either the north pole or south pole facing upwards. These are interpreted as 1 or 0 respectively and are detected by the coil linked to the datalogger as the disc spins.

(a) The diagram below shows one of the magnets on this model. Sketch its magnetic field.

(2)



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(b) Figure 1 shows how the magnetic flux varies as an upward-facing north pole moves beneath the coil. Figure 2 shows the corresponding output from the coil.

Figure 1

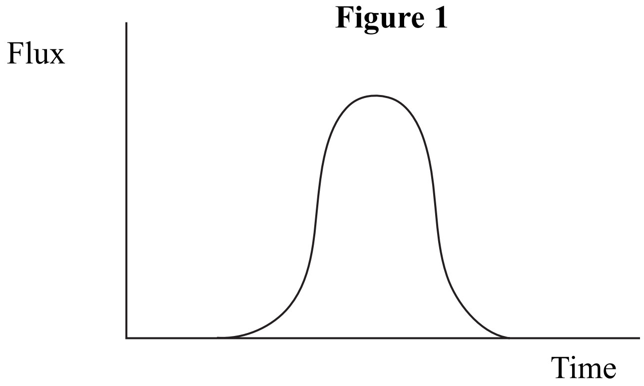
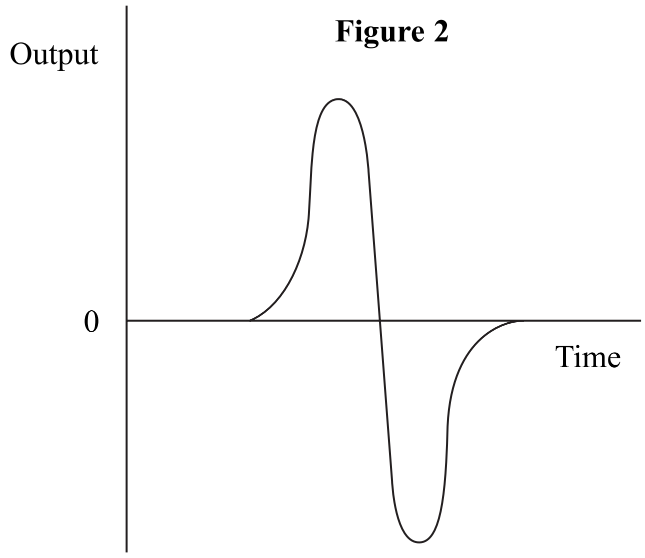


Figure 2



Explain how the output is generated and why it has this shape.

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(5)

Leave blank

(c) Show that the maximum number of sequences possible with ten magnets (as on this model) is about 1000.

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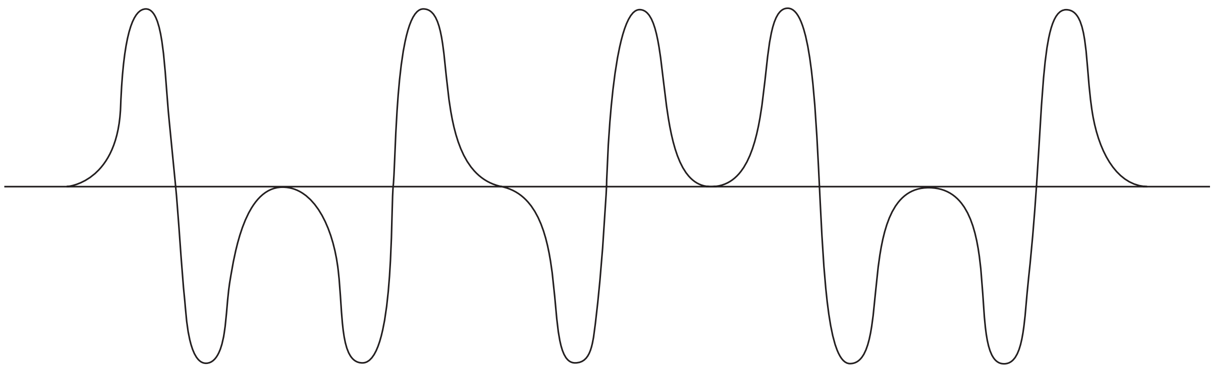
(1)

(d) The diagram shows an output generated during part of one trial.



Write the number sequence represented by this output. Remember: a north pole facing upwards is interpreted as 1 and a south pole upwards as 0.

....

(1)

(e) A real hard disc spins at very high speeds, making 7200 complete revolutions in one minute. The reading head is following a ring of magnetized regions with diameter 8.9 cm, and the length occupied by each separate magnetized region is 0.83 μm. Assume that there are no gaps between adjacent magnetized regions. Calculate the rate at which the head is reading bits of data.

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....

....

Rate = ...

(3)

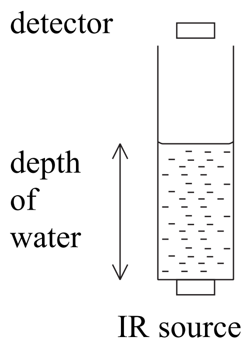
Q5

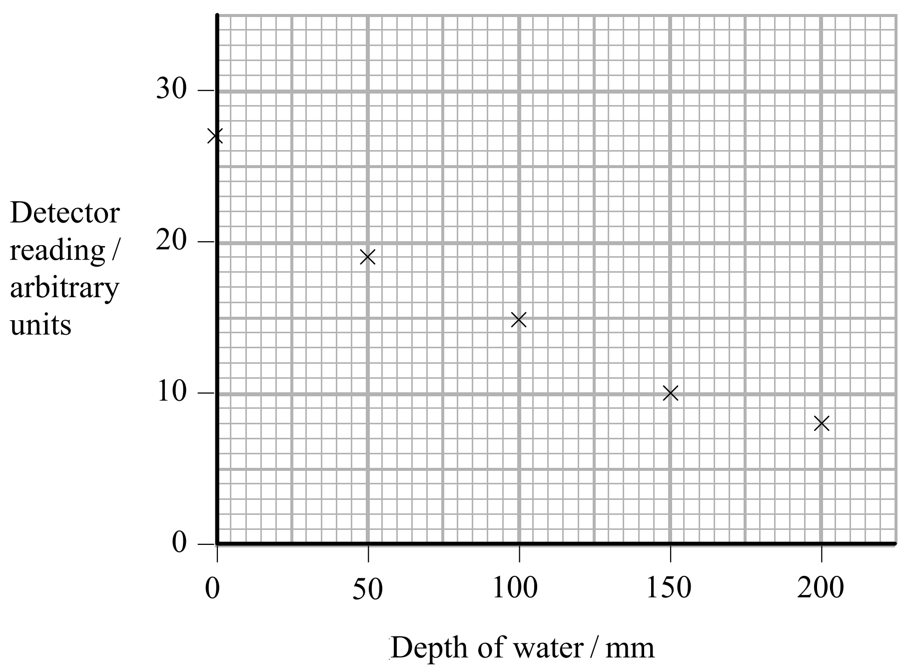
(Total 12 marks)

Leave blank

6. A student carries out an experiment to investigate how infra-red (IR) radiation is transmitted through water. She sets up apparatus as shown in the diagram, and reads the detector for different depths of water. A graph of her results is shown below.

Use the information in the graph to find the value of the attenuation coefficient for the IR radiation as it travels through water. You will only obtain full marks if you use the blank grid to plot an appropriate graph.





N 2 3 5 9 9 A 0 1 2 1 6

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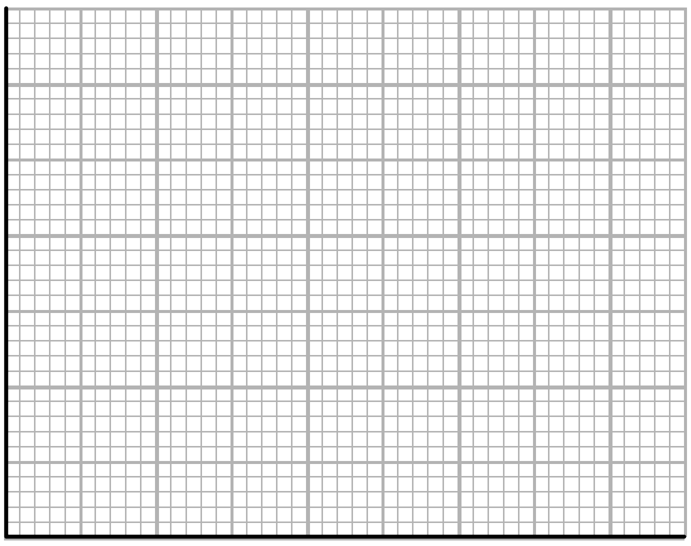

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.... **Q6**

(Total 5 marks)

TOTAL FOR PAPER: 60 MARKS

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List of data, formulae and relationships

Data

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

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 $P = 1/f$

N 2 3 5 9 9 A 0 1 5 1 6

Turn over

Unit 2

Physics for life

Quantum Phenomena

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

Materials

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

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

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	$Q = Q_0 e^{-t/RC}$

Magnetic Effects of Currents

Faraday's and Lenz's Laws	$E = -d(N\Phi)/dt$