Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

For Examiner's Use

General Certificate of Education
January 2008
Advanced Level Examination

PHYSICS (SPECIFICATION A) **PA04**
Unit 4 Waves, Fields and Nuclear Energy

Section B

Monday 21 January 2008 9.00am to 10.30 am

For this paper you must have:
- a pencil and a ruler
- a calculator.

Time allowed: The total time for Section A and Section B of this paper is 1 hour 30 minutes.

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this section is 45.
  This includes up to two marks for the Quality of Written Communication.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- A *Data Sheet* is provided on pages 3 and 4 of Section A. You may wish to detach this perforated sheet at the start of the examination.
- Questions 2(a) and 3(a) should be answered in continuous prose. In these questions you will be marked on your ability to use good English, to organise information clearly and to use specialist vocabulary where appropriate.

For Examiner's Use			
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
Total (Column 1) →			
Total (Column 2) →			
Quality of Written Communication			
TOTAL			
Examiner's Initials			

Answer **all** questions.

You are advised to spend about **one hour** on this section.

1 (a) (i) State **two** conditions which have to be satisfied for the formation of a stationary wave.

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(ii) When a stationary wave is formed on a string that is stretched between two fixed points, what additional condition concerning the length of the string must be satisfied?

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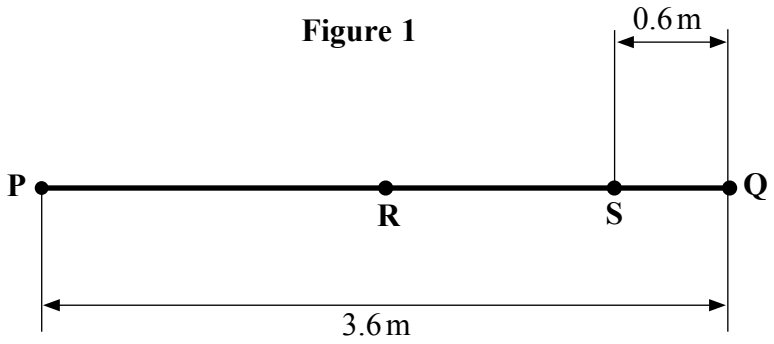
(3 marks)

(b) **Figure 1** shows the undisturbed position of a string stretched between the two points, **P** and **Q**, which are 3.6 m apart. The string is vibrated transversely at a frequency of 30 Hz, causing waves to travel along it at a speed of 72 m s^{-1}.

Figure 1



(i) Calculate the wavelength of the waves on the string.

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(ii) Draw on **Figure 1** the appearance of the stationary wave formed under these conditions.

(iii) Compare the vibrations of the mid-point **R** of the string with those of point **S**, which is 0.6 m from **Q**, with reference to amplitude, frequency and phase.

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(4 marks)

7

Turn over for the next question

2 (a) An experiment is to be carried out to determine the capacitance of a capacitor by measuring the potential difference V across it at various times t as it discharges through a resistor. The timing is to be carried out using a stopwatch. If the capacitance is known to be about 30 μF, suggest a suitable value for the resistance of the resistor, and explain why you have chosen this value.

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

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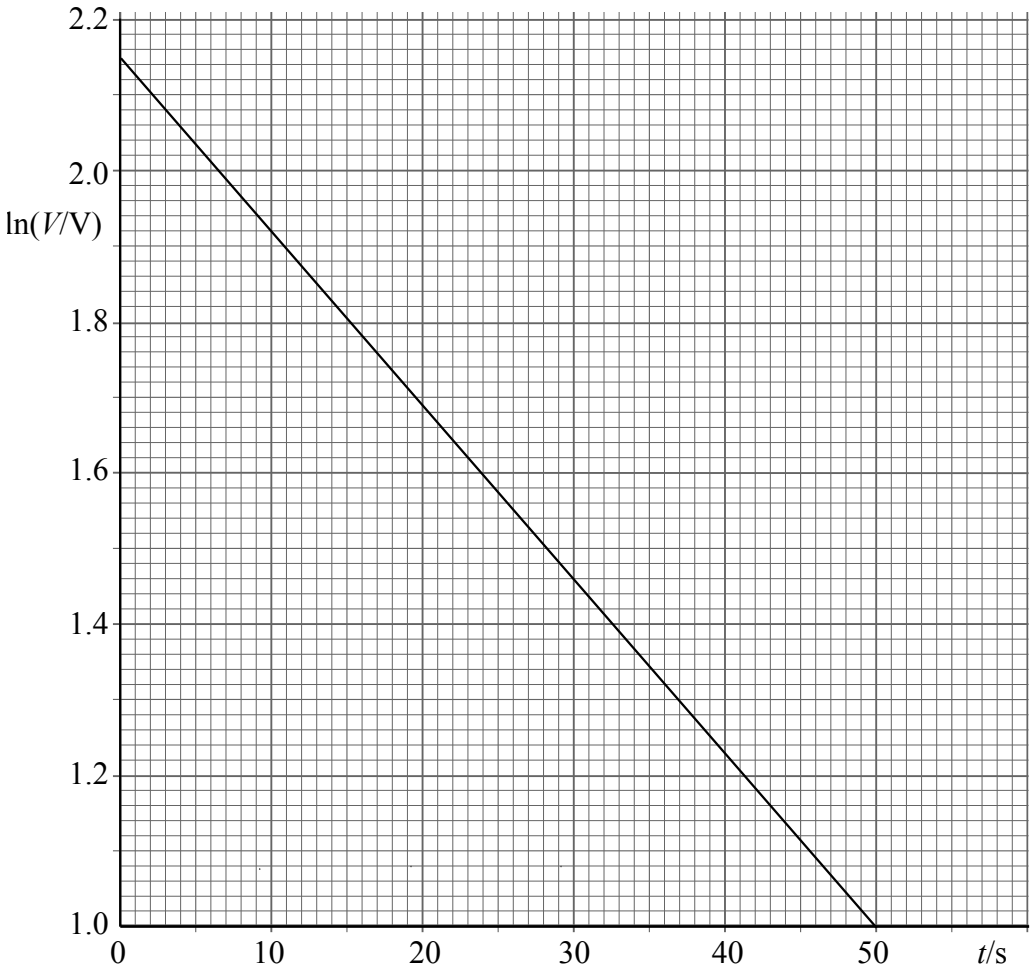
(3 marks)

(b) A similar experiment, in which the resistor had a resistance of 91 kΩ, gave the graph of ln V against t shown on the opposite page.



Use this graph to calculate

(i) the pd across the capacitor when $t = 0$,

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(ii) the time constant for the discharging circuit,

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(iii) the capacitance of the capacitor used in this experiment.

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(5 marks)

8

3 (a) Electrons experience forces in electric fields. In each of the following cases, state the direction of the force that acts on a moving electron, and describe and explain the electron's subsequent motion.

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

(i) An electron enters a uniform electric field that is directed at right angles to the electron's velocity at the point of entry.

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(ii) An electron enters a uniform electric field whose direction is the same as that of the electron's velocity at the point of entry.

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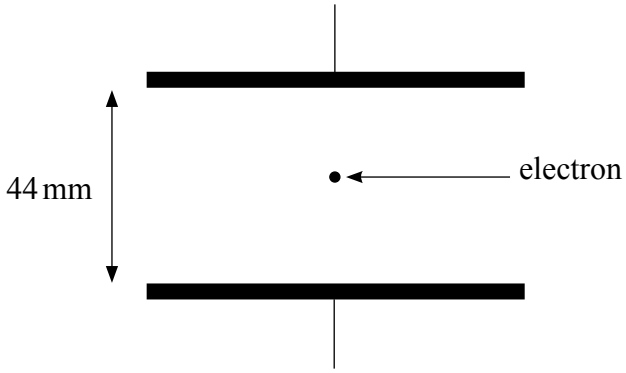
(5 marks)

(b) **Figure 2** shows two parallel metal plates, 44 mm apart, which have a pd of 110 V applied across them, with an electron between them.

Figure 2



Calculate

(i) the electric field strength between the plates,

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(ii) the magnitude of the force on the electron when it is between the plates,

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(iii) the kinetic energy, in J, that is gained by the electron when it starts from rest at one plate and crosses to the other plate.

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(4 marks)

9

4 (a) In order for fusion of two nuclei to take place, they have to be brought together to a separation of about 2 fm.

(i) Show that the electrostatic potential energy of a system consisting of two deuterium ($^{2}_{1}\mathrm{H}$) nuclei at a separation of 2 fm is about 1×10^{-13} J.

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(ii) Two deuterium nuclei may be brought to this separation by causing them to collide with equal and opposite velocities. Calculate the minimum speed required by **each** nucleus for the system to have the potential energy calculated in part (a)(i).

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(5 marks)

(b) One reaction that can occur when deuterium nuclei undergo fusion is

$$^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{3}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{p}$$

(i) Calculate the energy released, in J, by this reaction.

mass of $^{2}_{1}\mathrm{H}$ nucleus = 2.01355 u

mass of $^{3}_{1}\mathrm{H}$ nucleus = 3.01550 u

mass of proton = 1.00728 u

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(ii) How much energy is released, in J, from 1 kg of reactant in the above fusion reaction?

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(4 marks)

(c) State **two** reasons why fusion reactions would be preferable to fission reactions as an energy resource, provided the necessary conditions required for continuous fusion could be maintained.

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(2 marks)

11

5 (a) By considering the force equation for a satellite of mass m in an orbit of radius r around a planet of mass M, show that the orbital time period T of the satellite does not depend upon m.

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(3 marks)

(b) One of the moons of Jupiter, Ganymede, is the largest satellite in the solar system. Its orbital period is equal to 7.15 Earth days and the radius of its orbit is 1.07×10^6 km.

Calculate

(i) the angular speed of Ganymede in its orbit,

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(ii) the centripetal acceleration of Ganymede in its orbit,

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(iii) the mass of Jupiter.

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(5 marks)

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Quality of Written Communication *(2 marks)*

2

END OF QUESTIONS

There are no questions printed on this page