Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

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General Certificate of Education
June 2005
Advanced Level Examination

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Section B

Thursday 16 June 2005 Morning Session

In addition to this paper you will require:
- a calculator;
- a pencil and a ruler.

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 in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this Section is 45.
- Mark allocations are shown in brackets.
- Section A and Section B of this paper together carry 15% of the total marks for Physics Advanced.
- 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.
- You are expected to use a calculator where appropriate.
- In questions requiring description and explanation you will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary where appropriate. The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions.

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

1

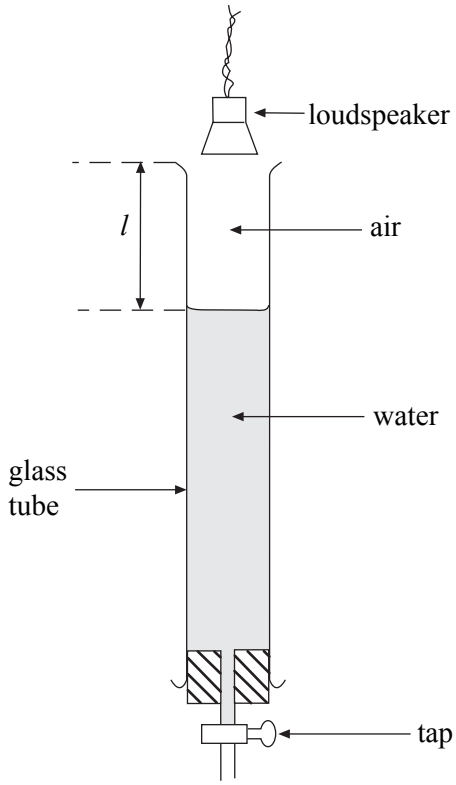

Figure 1

A small loudspeaker emitting sound of constant frequency is positioned a short distance above a long glass tube containing water. When water is allowed to run slowly out of the tube, the intensity of the sound heard increases whenever the length *l* (shown in **Figure 1**) takes certain values.

(a) Explain these observations by reference to the physical principles involved.

You may be awarded marks for the quality of written communication in your answer.

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(4 marks)

(b) With the loudspeaker emitting sound of frequency 480 Hz, the effect described in part (a) is noticed first when $l = 168$ mm. It next occurs when $l = 523$ mm.

Use both values of l to calculate

(i) the wavelength of the sound waves in the air column,

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(ii) the speed of these sound waves.

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(4 marks)

8

TURN OVER FOR THE NEXT QUESTION

2 (a) State what is meant by *coherent sources* of light.

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(2 marks)

(b)

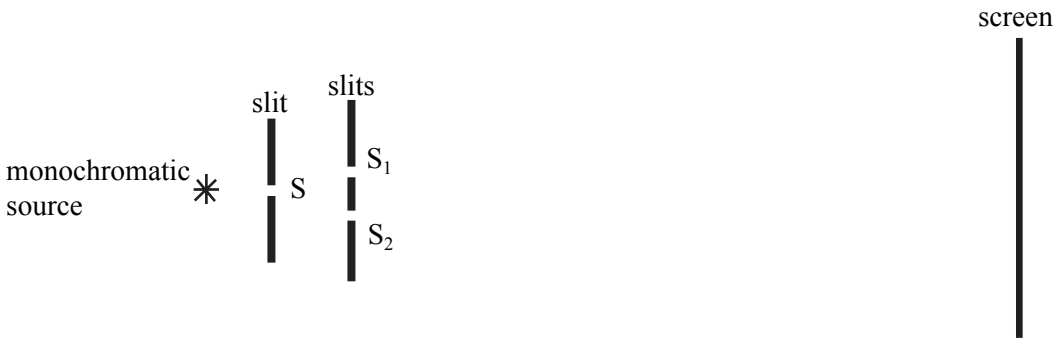

Figure 2

Young's fringes are produced on the screen from the monochromatic source by the arrangement shown in **Figure 2**.

You may be awarded marks for the quality of written communication in your answers.

(i) Explain why slit S should be narrow.

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(ii) Why do slits S_1 and S_2 act as coherent sources?

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(4 marks)

(c) The pattern on the screen may be represented as a graph of intensity against position on the screen. The central fringe is shown on the graph in **Figure 3**. Complete this graph to represent the rest of the pattern by drawing on **Figure 3**.

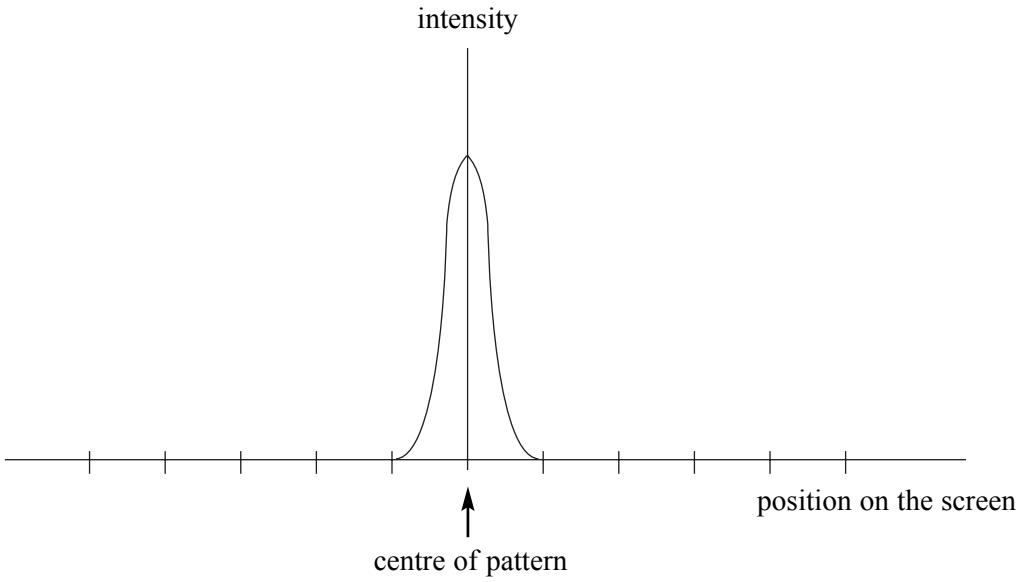

Figure 3

(2 marks)

8

TURN OVER FOR THE NEXT QUESTION

3 (a) As a capacitor was charged from a 12 V supply, a student used a coulomb meter and a voltmeter to record the charge stored by the capacitor at a series of values of potential difference across the capacitor. The student then plotted a graph of pd (on the *y*-axis) against charge (on the *x*-axis).

(i) Sketch the graph obtained.

(ii) State what is represented by the gradient of the line.

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(iii) State what is represented by the area enclosed by the line and the *x*-axis of the graph.

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(3 marks)

(b) The student then connected the capacitor as shown in **Figure 4** to carry out an investigation into the discharge of the capacitor.

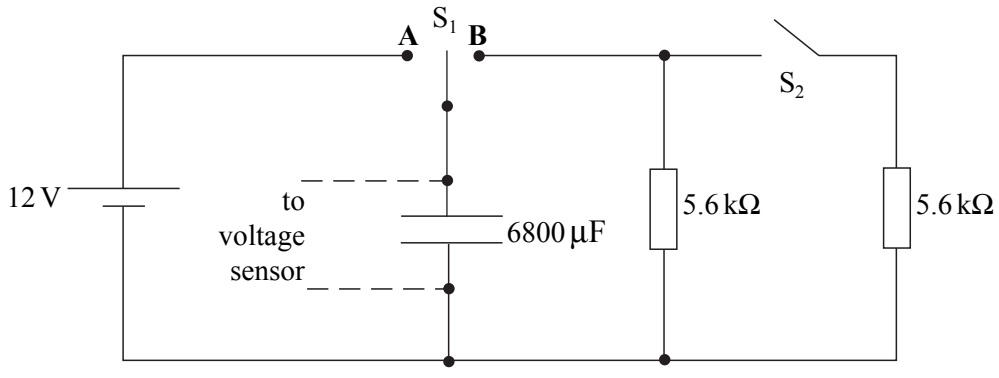

Figure 4

The student used a voltage sensor, datalogger and computer to obtain values for the pd across the capacitor at various times during the discharge.

(i) At time $t = 0$, with switch S_2 open, switch S_1 was moved from position **A** to position **B**. Calculate the pd across the capacitor when $t = 26$ s.

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(ii) At time $t = 26$ s, as the discharge continued, the student closed switch S_2. Calculate the pd across the capacitor 40 s after switch S_1 was moved from position **A** to position **B**.

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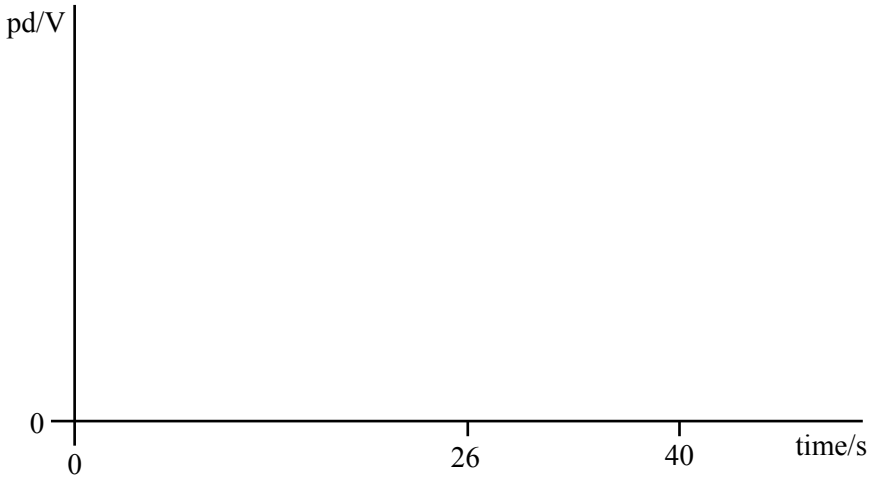
(iii) Sketch a graph of pd against time for the student's experiment described in parts (b)(i) and (b)(ii).



(7 marks)

10

4 (a) State, in words, Newton's law of gravitation.

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(3 marks)

(b) By considering the centripetal force which acts on a planet in a circular orbit, show that $T^2 \propto R^3$, where T is the time taken for one orbit around the Sun and R is the radius of the orbit.

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(3 marks)

(c) The Earth's orbit is of mean radius 1.50×10^{11} m and the Earth's year is 365 days long.

(i) The mean radius of the orbit of Mercury is 5.79×10^{10} m. Calculate the length of Mercury's year.

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(ii) Neptune orbits the Sun once every 165 Earth years.

Calculate the ratio $\frac{\text{distance from Sun to Neptune}}{\text{distance from Sun to Earth}}$.

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(4 marks)

10

TURN OVER FOR THE NEXT QUESTION

5 (a) The mass of a nucleus ${}^{A}_{Z}X$ is M.

(i) If the mass of a proton is m_p, and the mass of a neutron is m_n, give an expression for the mass difference Δm of this nucleus.

Δm = ...

(ii) Give an expression for the binding energy per nucleon of this nucleus, taking the speed of light to be c.

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(2 marks)

(b) **Figure 5** shows an enlarged portion of a graph indicating how the binding energy per nucleon of various nuclides varies with their nucleon number.

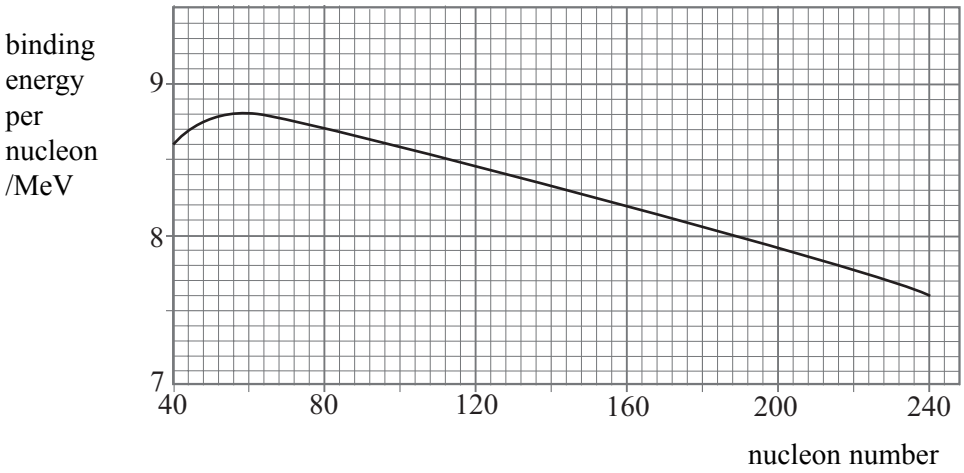

Figure 5

(i) State the value of the nucleon number for the nuclides that are most likely to be stable. Give your reasoning.

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(ii) When fission of uranium 235 takes place, the nucleus splits into two roughly equal parts and approximately 200 MeV of energy is released. Use information from **Figure 5** to justify this figure, explaining how you arrive at your answer.

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(5 marks)

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QUALITY OF WRITTEN COMMUNICATION *(2 marks)*

$\frac{}{2}$

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE