Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2002
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION A) PHA8/W
Unit 8 Nuclear Instability: Turning Points in Physics Option

Friday 21 June 2002 Afternoon Session

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

Time allowed: 1 hour 15 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 paper is 40.
- Mark allocations are shown in brackets.
- The paper carries 10% of the total marks for Physics Advanced.
- A *Data Sheet* is provided on pages 3 and 4. 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			

Data Sheet

- A perforated *Data Sheet* is provided as pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- You may wish to detach this sheet before you begin work.

DATA SHEET

DATA SHEET

TURN OVER FOR THE FIRST QUESTION

SECTION A NUCLEAR INSTABILITY

Answer **all** parts of the question.

1 (a) State which type of radiation, α, β or γ,

(i) produces the greatest number of ion pairs per mm in air,

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(ii) could be used to test for cracks in metal pipes.

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(2 marks)

(b) Specific radioisotope sources are chosen for tracing the passage of particular substances through the human body.

(i) Why is a γ emitting source commonly used?

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(ii) State why the source should **not** have a very short half-life.

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(iii) State why the source should **not** have a very long half-life.

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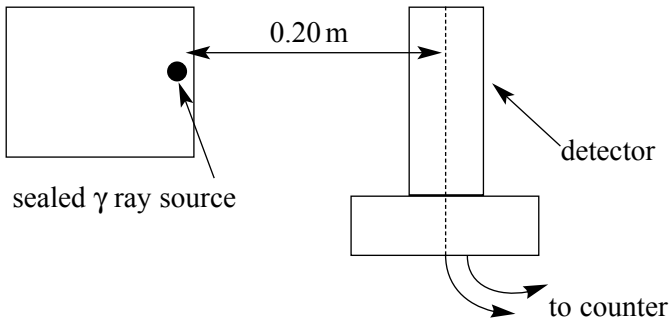
(3 marks)

(c) A detector, placed 0.20 m from a sealed γ ray source, receives a mean count rate of 2550 counts per minute. The experimental arrangement is shown in the diagram below. The mean background radiation is measured as 50 counts per minute.



Calculate the least distance between the source and the detector if the count rate is not to exceed 6000 counts per minute.

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(5 marks)

10

TURN OVER FOR THE NEXT QUESTION

SECTION B TURNING POINTS IN PHYSICS

Answer **all** questions.

2 (a) A certain metal has a work function of 1.2 eV.

(i) Explain what is meant by this statement.

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(ii) Calculate the threshold wavelength of light for this metal surface.

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(3 marks)

(b) When blue light is incident on a certain metal surface, electrons are emitted from the surface. No electrons are emitted when red light, instead of blue light, is incident on the same surface at the same potential.

(i) Use Einstein's theory of light to explain these observations.

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(ii) Outline the significance of Einstein's explanation.

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(5 marks)

8

3 (a) In the Scanning Tunnelling Microscope (STM), electrons cross a gap between a sharp metal tip and a conducting surface when the gap is small and a potential difference exists across it.

(i) Explain, in terms of wave particle duality, why an electron can cross this small gap.

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(ii) Explain, why it is necessary for a potential difference to exist across the gap?

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(4 marks)

(b) Calculate the speed of an electron which has a de Broglie wavelength of 1 nm.

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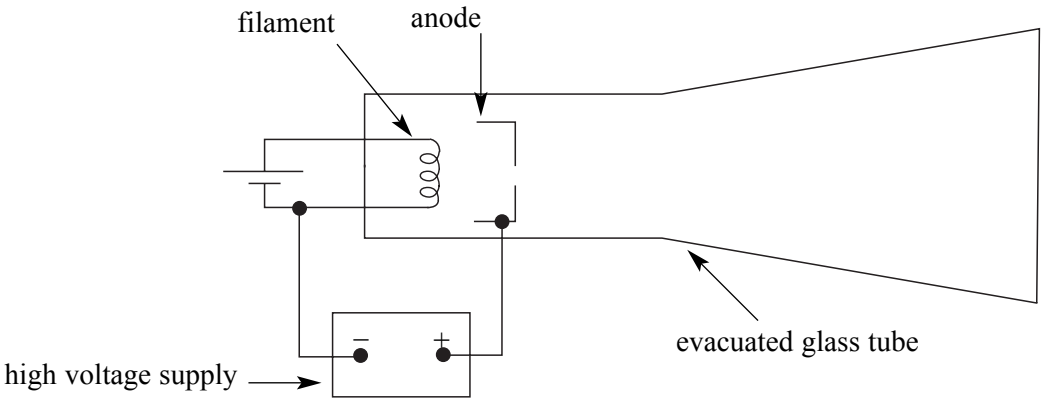
(2 marks)

6

4 (a) A beam of monoenergetic electrons is produced by *thermionic emission* from a metal filament, using an arrangement represented in the diagram.



(i) Describe the process of thermionic emission.

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(ii) Explain why thermionic emission is negligible when the filament current is too low.

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(4 marks)

(b) The anode is at a positive potential of 4200 V with respect to the filament.

(i) Calculate the kinetic energy, in J, of an electron in the beam in part (a) as it passes through the anode.

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(ii) Calculate the speed of the electrons in this beam as they pass through the anode. Ignore relativistic effects.

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(4 marks)

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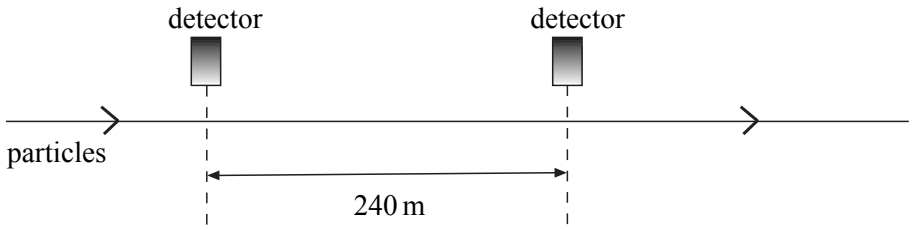
8

5 (a) In a particle beam experiment, a short pulse of 1ns duration of particles moving at constant speed passed directly between 2 detectors at a fixed distance apart of 240 m. The pulse took 0.84 μs to travel from one detector to the other.



(i) Calculate the speed of the particles.

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(ii) Calculate the distance between the two detectors in the frame of reference of the particles.

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(4 marks)

QUESTION 5 CONTINUES ON THE NEXT PAGE

(b) In a 'thought experiment' about relativity, a student stated that a twin who travelled from the Earth to a distant planet and back at a speed close to the speed of light would be the same age on return as the twin who stayed on Earth. Explain why this statement is **not** correct.

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(4 marks)

8

END OF QUESTIONS