

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

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General Certificate of Education
January 2002
Advanced Level Examination



PHYSICS (SPECIFICATION A) PHA6/W
Unit 6 Nuclear Instability: Medical Physics Option

Monday 28 January 2002 Morning Session

<p>In addition to this paper you will require:</p> <ul style="list-style-type: none"> • a calculator; • a pencil and a ruler.

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

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.

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

Turn over ▶

DATA SHEET

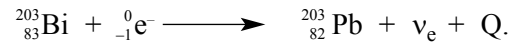
TURN OVER FOR THE FIRST QUESTION

Turn over ▶

SECTION A NUCLEAR INSTABILITY

Answer **all** parts of the question.

- 1 (a) The nuclide ${}_{83}^{203}\text{Bi}$ can decay by *electron capture* to become an isotope of lead as shown in the following equation,



- (i) Explain what is meant by electron capture.

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- (ii) Give **one** reason why electromagnetic radiation is emitted following this process.

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- (iii) Give the equation for another process in which ${}_{83}^{203}\text{Bi}$ is converted into an isotope of lead.



(5 marks)

- (b) The nuclide $^{203}_{83}\text{Bi}$ is also an α particle emitter. An initial measurement of the α particle activity of a sample of this isotope gives a corrected count rate of $1200 \text{ counts s}^{-1}$. After an interval of 24 hours the corrected rate falls to $290 \text{ counts s}^{-1}$. Assume that corrections have been made for the radiation both from daughter products and background radiation.

- (i) Show that the decay constant of $^{203}_{83}\text{Bi}$ is about $1.6 \times 10^{-5} \text{ s}^{-1}$.

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- (ii) Calculate the half-life of this sample.

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- (iii) Calculate the number of $^{203}_{83}\text{Bi}$ nuclei in the sample when the corrected count rate was $1200 \text{ counts s}^{-1}$.

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(5 marks)

10

SECTION B MEDICAL PHYSICS

Answer **all** questions.

2 (a) State **two** applications of laser radiation in medicine.

1

2

(2 marks)

(b) For **one** of the applications which you have given, describe how the laser radiation is applied and state any safety features needed.

method of application

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safety features

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(4 marks)

6

3 Electrodes are attached to the chest of a healthy person and a normal ECG waveform is obtained.

(a) State **two** ways of ensuring good electrical contact between the electrodes and the person.

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(2 marks)

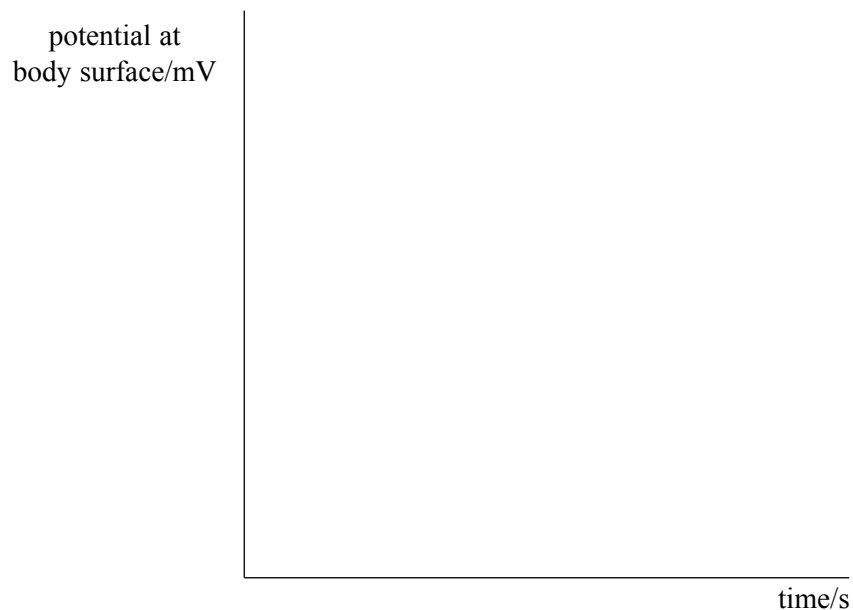
(b) State **two** properties of the amplifier needed to amplify the signal from the electrodes.

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(2 marks)

(c) Sketch, on the axes below, the waveform that you would expect to obtain. Label the axes with appropriate scales.



Mark on the waveform where the following occur:

- (i) atrial depolarisation
- (ii) ventricular depolarisation
- (iii) ventricular repolarisation.

(5 marks)

9

Turn over ▶

4 An eye test shows that a person suffers from astigmatism.

(i) Give the main cause of astigmatism.

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(ii) State the effect of astigmatism on the image seen.

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(iii) State the type of lens needed to correct this defect of vision.

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(iv) Give **two** quantities which must be known in order to manufacture the correcting lens.

1

2

(5 marks)

5

- 5 (a) State **two** reasons why the *logarithmic* dB scale is used to compare sounds of different intensities.

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(2 marks)

- (b) Another scale used to compare sounds of different intensities is the dBA scale. What are the main differences between the dBA and the dB scales?

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(3 marks)

- (c) A reading of 94 dB is obtained on a sound meter placed near a drill. Calculate the intensity of the sound incident on the meter.

reference threshold intensity $I_0 = 1.0 \times 10^{-12} \text{ W m}^{-2}$

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(3 marks)

QUESTION 5 CONTINUES ON THE NEXT PAGE

Turn over ▶

- (d) An identical drill is now placed next to the first drill and both are switched on.
Calculate the new reading on the sound meter.

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(2 marks)

10

END OF QUESTIONS