



Rewarding Learning

ADVANCED

General Certificate of Education

2019

Centre Number

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Candidate Number

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Life and Health Sciences

Assessment Unit A2 3

assessing

Medical Physics

[AZ031]

FRIDAY 31 MAY, AFTERNOON



AZ031

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Write your answers in the spaces provided in this question paper.

Answer **all eight** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You may use an electronic calculator.

Quality of written communication will be assessed in question **1(ii)**.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	

Total Marks	
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[8]

Examiner Only	
Marks	Remark

2 Table 2.1 shows data for some radioisotopes.

Table 2.1

Isotope	Half-life / days		
	T_{Physical}	$T_{\text{Biological}}$	$T_{\text{Effective}}$
^{90}Sr	1.1×10^4	1.8×10^4	
^{32}P	14.3	1155	14.1
^{131}I	8	135	7.55

The rate of decrease of radiation exposure is affected by both the radioactive half-life, T_{Physical} , and biological half-life, $T_{\text{Biological}}$, giving an effective half-life, $T_{\text{Effective}}$, for the isotope in the body.

(a) Explain why it is important that a patient has minimal exposure to a radioisotope.

_____ [2]

Phosphorus, ^{32}P , and strontium, ^{90}Sr , are **both taken up by bone**.

(b) (i) Describe and explain the effects this will have, if any, on the radioactive half-life, T_{Physical} , and on the biological half-life, $T_{\text{Biological}}$.

T_{Physical} _____

_____ [2]

$T_{\text{Biological}}$ _____

_____ [2]

Examiner Only	
Marks	Remark

- (i) Complete **Table 3.1** to give one method of use and one limitation for each of these thermometers.
Write your answers in the blank boxes below.

Table 3.1

Type of Thermometer	Method of use	Limitation
Mercury in glass thermometer		
Digital thermometer		
Electronic thermometer		

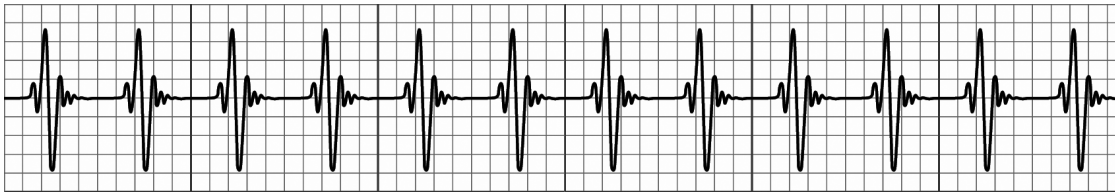
[6]

- (ii) Mercury in glass thermometers are no longer commonly used by medical professionals to measure body temperature. Suggest a reason why they are considered unsafe to use for this purpose.

_____ [1]

Examiner Only	
Marks	Remark

An electrocardiogram (ECG) works by measuring pulses of electric current flowing in the heart. These electrical impulses are then recorded as special tracings on strips of graph paper as seen in **Fig. 4.1**.



© AlexanderZam / Getty Images

Fig. 4.1

Long QT syndrome is a genetic heart condition which causes problems with the electrical activity of the heart.

It causes short episodes of abnormally fast heart rhythm which last for about a minute.

This can be triggered by stimuli such as stress, sudden noises, strenuous exercise and even sleeping.

(b) (i) State **two** other medical abnormalities which may be detected through the use of an electrocardiogram.

1. _____

 2. _____

- [2]

(ii) Describe the limitations of an ECG when used to determine if a patient has long QT syndrome.

- _____

- [2]

Examiner Only	
Marks	Remark

5 Fig. 5.1 shows a simplified X-ray tube used in the production of conventional X-rays and CT scans.

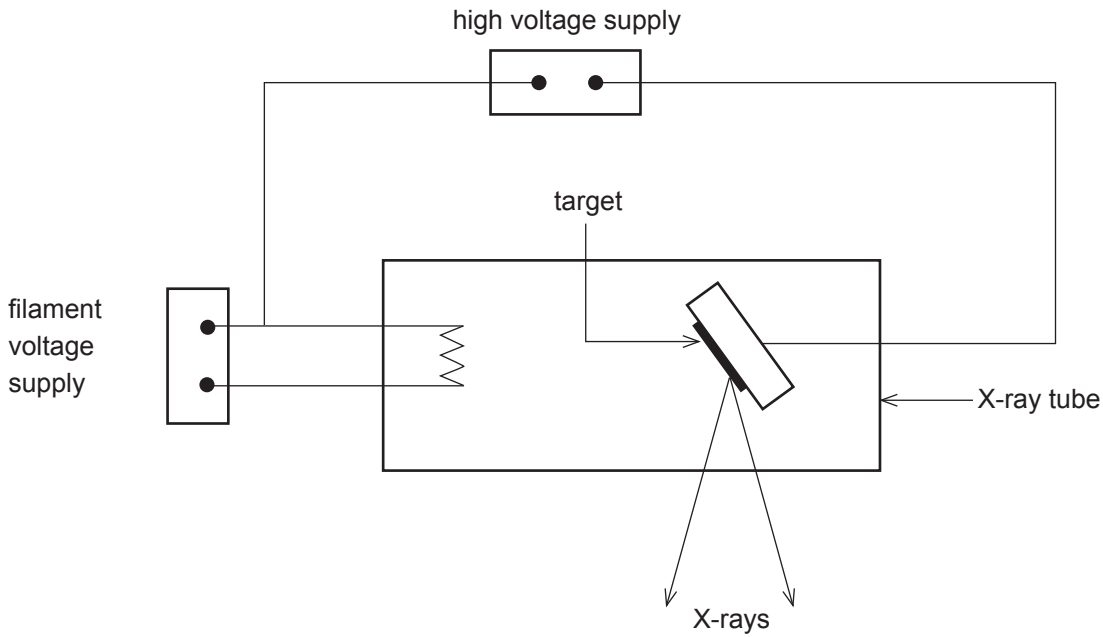


Fig. 5.1

(a) (i) Table 5.1 lists some possible properties of X-rays. Tick the appropriate boxes to indicate the correct properties of X-rays. One example has been provided.

Table 5.1

Properties	
High energy wave	✓
Low frequency	
Cause ionisation of matter	
Has a relative charge of -1	
Can travel in a vacuum	
Part of the electromagnetic spectrum	
Can only travel a few centimetres in air	

[3]

Examiner Only	
Marks	Remark

- 6 A technician carried out an experiment to determine the activity of a radioactive source, **A**. The results collected from this experiment are shown in **Table 6.1** below.

Table 6.1

Reading	Number of counts in 2 minutes
1	287
2	300
3	298

- (a) (i) Activity is measured in becquerels, Bq.

What is the meaning of **1 Bq**?

_____ [1]

- (ii) Using all the results in **Table 6.1**, calculate the activity when source **A** is present. Give your answer to 3 significant figures.

You are advised to show your working.

Activity = _____ Bq [3]

The technician then recorded the counts for the background radiation over the same period of time and calculated the background activity to be 0.37 Bq.

- (iii) What is background radiation?

_____ [1]

- (iv) Calculate the activity of radioactive source, **A**.

Activity = _____ Bq [1]

Examiner Only

Marks Remark

- (b) (i) In another experiment the half-life of a radioactive source, **B**, is found to be 77.3 days. Show that the decay constant is $1.04 \times 10^{-7} \text{ s}^{-1}$.

You must show your working.

[3]

- (ii) If the activity of source **B** at the time of the experiment was 85.4 Bq, calculate the activity 100 days later.

You are advised to show your working.

Activity = _____ Bq [4]

Examiner Only

Marks Remark

- 8 (a) In a B-scan, a 2.2 MHz ultrasound beam travels at a speed of 1.5 km s^{-1} through soft tissue.

If the specific acoustic impedance of soft tissue is $1.63 \times 10^6 \text{ kg m}^{-2} \text{ s}^{-1}$, calculate the density of the soft tissue.

You are advised to show your working.

Density = _____ kg m^{-3} [4]

The specific acoustic impedance for some materials is provided in **Table 8.1**.

Table 8.1

Material	Specific acoustic impedance/ $\text{kg m}^{-2} \text{ s}^{-1}$
Skin	1.63×10^6
Oil	1.43×10^6
Fat	1.38×10^6
Bone	7.78×10^6
Muscle	1.70×10^6

Examiner Only

Marks

Remark

(c) (i) Compare the visual output and uses of ultrasonic A-scans and B-scans.

_____ [2]

(ii) Which type of ultrasonic scan requires the operator to move the probe continuously across the surface of the skin?

_____ [1]

(iii) In an A-scan of a tumour the time taken between the reflected pulses from each surface of the tumour is $60\ \mu\text{s}$. If the speed of ultrasound in the tumour is $1500\ \text{m s}^{-1}$, calculate the diameter of the tumour.

You are advised to show your working.

diameter = _____ m [5]

THIS IS THE END OF THE QUESTION PAPER

Examiner Only

Marks Remark

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