

OCR

A Level

A Level Physics

Medical Physics

Name:

M M E

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Total Marks: /30

1. Ultrasound imaging is quick, cheap, non-invasive and non-ionising. It is therefore a regularly used diagnostics tool in medicine. In this question you will explore two types of ultrasound imaging: Doppler scans and regular ultrasound.

Total for Question 1: 11

(a) Define ultrasound waves.

[1]

(b) State the major difference between A-type and B-type ultrasound images.

[1]

(c) Why is a special gel used in ultrasound imaging? Perform calculations to back up your explanation. The densities and ultrasound speeds of some relevant media are listed below.

[4]

Medium	Density / kgm^{-3}	Ultrasound velocity / ms^{-1}
Air	1.300	340
Gel	1040	1590
Skin	1070	1590

(d) Why, for Doppler ultrasound scans, must the transducer be held at an angle to skin? [1]

(e) Ultrasound with a frequency of 10 MHz is directed at 60° to a blood vessel measuring 1 mm in diameter. A Doppler shift of 700 Hz is observed; the speed of ultrasound in blood is 1650 ms^{-1} . Calculate the volume of blood that passes a given point in the vessel in a period of 1 minute. [4]

2. X-ray scans take many forms. However, the basic mechanisms are uniform to all. This question tackles the fundamental aspects of x-ray imaging.

Total for Question 2: 13

(a) Briefly describe how an x-ray is produced. What would be the minimum wavelength produced if the accelerating potential difference is 60 kV? [4]

(b) State two examples of scattering mechanisms. [2]

(c) Give two advantages and two disadvantages of CAT scans compared to standard x-ray imaging techniques. [2]

(d) Explain why iodine might be given to a patient who is about to undergo an x-ray scan? [2]

(e) 1 cm slices of bone and muscle are subjected to x-rays of the same intensity. In the case of the bone sample, the transmitted intensity is 10 W and the attenuation coefficient is 0.60 cm^{-1} . Calculate the attenuation coefficient of muscle, given that the transmitted intensity of the x-rays is 15 W. [3]

3. As well as ultrasound and x-ray imaging, many other types of diagnostic scans are used. In some, medical tracers are needed to highlight the particular body part.

Total for Question 3: 6

(a) Briefly describe how an image is produced using a gamma camera.

[3]

(b) When might technetium-99m and fluorine-18 be used in medical diagnostics? Why must they be produced in proximity to the site on which they are used?

[3]