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QUESTION WORKBOOK

Ultrasound imaging

Medical physics · Year 13

AQA 3.10.4 · CIE 24.1 · OCR A 6.5.3

12 questions · 32 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 Describe how a piezoelectric transducer both generates and detects ultrasound. [2]

A2 An echo returns 90 μs after a pulse enters soft tissue, where ultrasound travels at 1540 m s^{-1}. Calculate the depth of the reflecting boundary. [2]

A3 State what is meant by the acoustic impedance of a medium, and give its defining equation. [2]

SECTION B · Standard

B1 Calculate the acoustic impedance of liver tissue, of density 1075 kg m^{-3}, in which sound travels at 1590 m s^{-1}. [2]

B2 A boundary lies 3.5 cm below the skin. Calculate the time after the pulse enters the tissue at which its echo returns (speed of sound in tissue 1540 m s^{-1}), and state why the scanner must finish listening before it sends the next pulse. [3]

B3 Distinguish between an A-scan and a B-scan. [2]

B4 Ultrasound meets a boundary between muscle ($Z = 1.70 \times 10^6$ kg m^{-2} s^{-1}) and liver ($Z = 1.63 \times 10^6$ kg m^{-2} s^{-1}). Calculate the fraction of the incident intensity that is reflected. [3]

B5 Explain, in terms of acoustic impedance, why coupling gel is needed between the transducer and the skin. [3]

SECTION C · Stretch

C1 The acoustic impedance of air is about 430 kg m^{-2} s^{-1} and of soft tissue about 1.63 × 10^{6} kg m^{-2} s^{-1}. Calculate the fraction of intensity reflected at an air-tissue boundary, and comment on the result. [3]

C2 In an A-scan of an organ, echoes return 52 µs and 78 µs after the pulse enters the tissue (c = 1540 m s^{-1}). Calculate the depth of each surface of the organ and hence its thickness along the beam. [4]

C3 A student says higher-frequency ultrasound always gives a better scan. Discuss whether this is true. [3]

C4 Give two reasons why ultrasound, rather than X-rays, is used for antenatal scanning, and one limitation of ultrasound imaging. [3]