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QUESTION WORKBOOK

X-rays and CT scanning

Medical physics · Year 13

AQA 3.10.5 · CIE 24.2 · OCR A 6.5.1

12 questions · 34 marks

PRINT EDITION

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SECTION A · Warm-up

A1 Describe how X-rays are produced in an X-ray tube. [3]

A2 An X-ray tube operates at 65 kV. Calculate the maximum energy of a photon in the beam. [2]

A3 State the equation for the attenuation of X-rays passing through matter, defining each symbol. [2]

SECTION B · Standard

B1 Calculate the minimum wavelength of X-rays from a tube operating at 100 kV. [3]

B2 Soft tissue has an attenuation coefficient of 0.21 cm^{-1} for one diagnostic beam. Calculate the fraction of the incident intensity transmitted through 4.0 cm of this tissue. [3]

B3 An operator increases the tube voltage. Separately, the operator increases the tube current. State the effect of each change on the X-ray beam. [2]

B4 The attenuation coefficient of bone for a certain beam is 0.60 cm^{-1}. Calculate the half-value thickness of bone, the thickness that halves the beam intensity. [3]

B5 Explain why bone shows clearly on a plain X-ray image while two neighbouring soft tissues often do not, and how a contrast medium helps. [3]

SECTION C · Stretch

C1 A beam passes through soft tissue with $\mu = 0.35\ \text{cm}^{-1}$. Calculate the thickness that reduces the intensity to one tenth of its incident value. [3]

C2 Explain the principle of CT scanning, and state one advantage and one disadvantage of a CT scan compared with a plain X-ray image. [4]

C3 An X-ray tube runs at 120 kV with a beam current of 2.0 mA. Calculate the maximum photon energy, and the number of electrons striking the target each second. [3]

C4 Most of the energy delivered to the target of an X-ray tube does not become X-rays. State what it becomes, and explain two design features of the anode that deal with it. [3]