

A Level • OCR • Physics

 19 mins 3 questions

Structured Questions

X-rays

X-Ray Tube / X-ray Attenuation Mechanisms / Calculating X-ray Attenuation / X-ray Imaging / CAT Scans

Easy (1 question)	/7
Medium (1 question)	/8
Hard (1 question)	/4
Total Marks	/19

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Easy Questions

- 1 (a) Describe the basic structure of an X-ray tube and explain how X-ray photons are produced. You may draw a labelled diagram.

[3]

(3 marks)

- (b) A beam of X-rays is directed at tissues in a patient. The X-ray photons interact with the atoms of the tissues. **Simple scatter** is one of the attenuation mechanisms. Name and describe **two** other attenuation mechanisms.

[4]

(4 marks)

Medium Questions

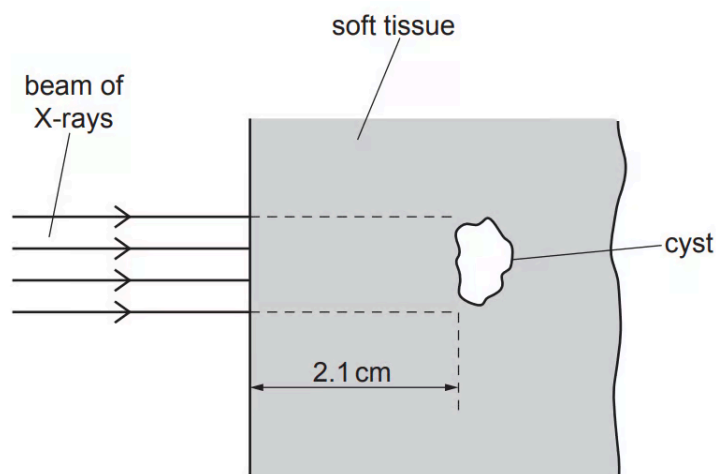
- 1 (a) A high-energy X-ray photon interacts with an electron of an atom through the **Compton effect**.

Describe this effect.

[2]

(2 marks)

- (b) The diagram below shows a beam of X-rays incident normally on some soft tissue.



The attenuation (absorption) constant of the soft tissue is 0.85 cm^{-1} . The intensity of the beam is $4.6 \times 10^3 \text{ W m}^{-2}$. There is a small cyst 2.1 cm from the surface of the soft tissue. The cross-sectional area of the cyst normal to the beam is $3.4 \times 10^{-4} \text{ m}^2$.

The beam is switched on for 30 s.

Calculate the X-ray energy incident on the cyst in a period of 30 s.

energy = J [4]

(4 marks)

- (c)** The attenuation coefficients of the cyst and the soft tissues in **(b)** were similar. This prevented imaging the cyst using a two-dimensional X-ray image.

Name a different X-ray technique that could be used to image the cyst. Explain the advantage of this technique.

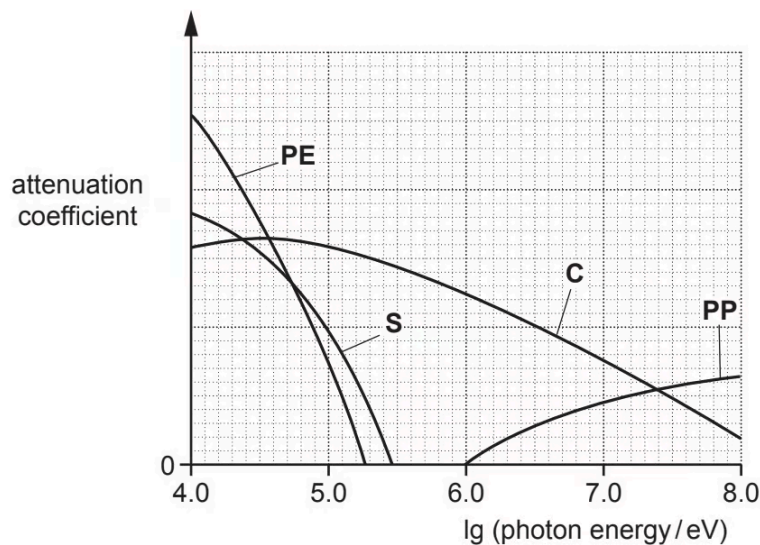
[2]

(2 marks)

Hard Questions

1 (a) X-ray photons interact with atoms.

The attenuation coefficient against $\lg(\text{photon energy})$ graphs for simple scattering (S), photoelectric effect (PE), Compton effect (C) and pair production (PP) are shown below.



For the X-ray tubes used in hospital, the X-ray photons have energy of about 10^5 eV.

State the attenuation mechanisms for these photons.

[1]

(1 mark)

(b) With the help of a calculation, explain the minimum photon energy shown on the graph for pair production.

[3]

(3 marks)