

Q1.A diagnostic X-ray tube produces a beam of X-rays. The beam passes through a diaphragm consisting of two pairs of lead sheets which can be moved at right angles to each other, and then through an aluminium filter.

(a) (i) State the use of the lead sheets.

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(1)

(ii) State the use of the aluminium filter.

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(1)

(b) When a monochromatic beam of X-ray photons is passed through an aluminium sheet of thickness 2.7 mm, its intensity is reduced by 8.3%.

Calculate the mass attenuation coefficient of aluminium for these X-rays.

State an appropriate unit for your answer.

density of aluminium = 2700 kg m^{-3}

mass attenuation coefficient unit

(5)

(Total 7 marks)

Q2. (a) In an X-ray tube, electrons are accelerated from rest through a pd of 72.4 kV

before they hit the target anode.

- (i) Calculate the kinetic energy of an electron as it reaches the anode. Give your answer to an appropriate number of significant figures.

answer = J

(2)

- (ii) Assuming that the electron gives up all this energy to form an X-ray photon, calculate the wavelength of the photon.

answer = m

(2)

- (b) X-rays are used in a CT scanner. Describe briefly how a CT scanner produces an image.

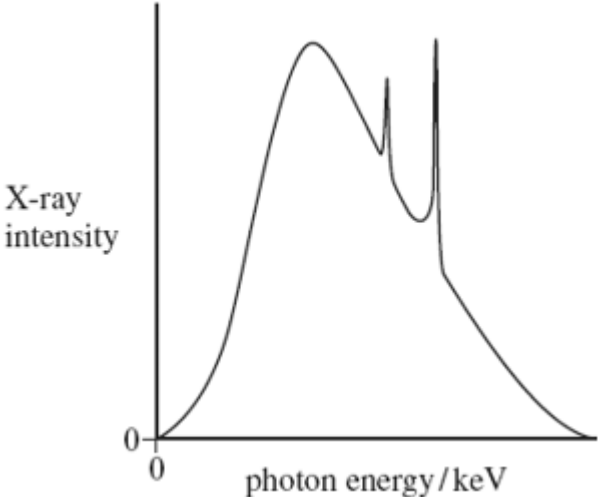
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(3)

(Total 7 marks)

Q3. (a) The X-ray spectrum for a certain X-ray tube target is shown in **Figure 1**. Explain the process which gives rise to spikes at certain photon energies.

Figure 1



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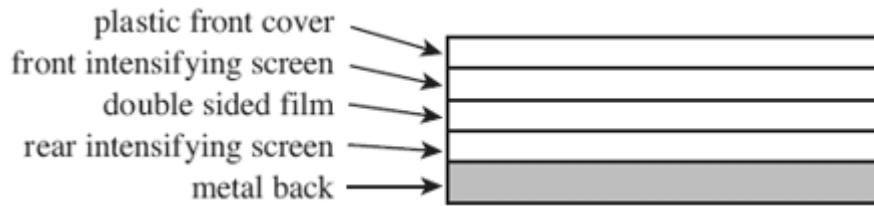
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(b) A film cassette, placed under a patient being X-rayed, is shown in **Figure 2**.

Figure 2



Explain how the intensifying screens in the film cassette achieve their purpose and state their benefit to the patient.

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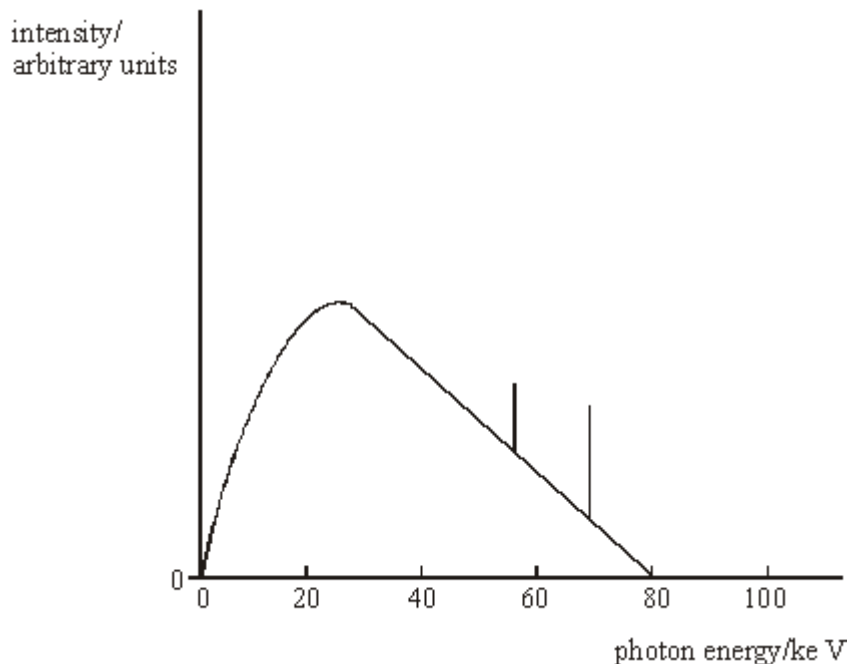
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(3)
(Total 6 marks)

Q4.



- (a) An X-ray tube operates with a pd across the tube of 80 kV. The figure above shows the X-ray spectrum emitted. Explain why the spectrum has spikes at specific photon energies.

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(2)

- (b) The pd across the tube is increased to 90 kV. Sketch on the figure above the X-ray spectrum produced at this new pd.

(3)

- (c) At the working pd of 80 kV, the anode current was 120 mA. The X-ray tube has an efficiency of 0.70 %. Calculate the rate of production of heat at the anode.

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(3)

(Total 8 marks)

Q5. In the course of diagnosis and treatment of a child's broken arm, several images of the arm are required. Similarly, to check the progress of a woman's pregnancy, several images of the foetus are required. **In each case**, state which imaging technique would probably be used and give **two** reasons for the choice.

Broken arm:

technique used

reason 1

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reason 2

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Foetus:

technique used

reason 1

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reason 2

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(Total 4 marks)

Q6. Diagnostic X-rays are produced using a rotating anode X-ray tube.

- (a) (i) State **two** methods which can be used to increase the intensity of the X-ray beam produced by the tube.

method 1

method 2

- (ii) For each method of increasing intensity, state the effect on the maximum X-ray photon energy.

method 1

method 2

(3)

- (b) Before taking an X-ray photograph, the X-ray beam emerging from the tube is passed through an aluminium filter. State and explain the reason for filtering the X-rays.

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(3)

(Total 6 marks)