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. (i) Explain what is meant by the *half-value thickness* of lead for X-rays.

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(ii) Calculate the linear attenuation coefficient of lead for 90 keV X-ray photons.

half value thickness of lead for 90 keV X-ray photons = 12mm.

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(iii) Calculate the thickness of lead needed to reduce the intensity of a beam of 90 keV X-ray photons to 5.0 % of the intensity incident on the lead.

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(Total 6 marks)

Q3. (a) When an X-ray image is obtained of certain organs, *image contrast enhancement* is necessary. Explain why image contrast enhancement is needed and describe how this might be achieved.

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(3)

(b) A monochromatic X-ray beam of intensity 3.2×10^{-2} W m^{-2} is incident on an aluminium sheet. Calculate the thickness of aluminium required to reduce the intensity of the X-ray beam to 1.2×10^{-2} W m^{-2}.

mass attenuation coefficient of aluminium, $\mu_m = 0.012$ m^2 kg^{-1}

density of aluminium, $\rho = 2700$ kg m^{-3}

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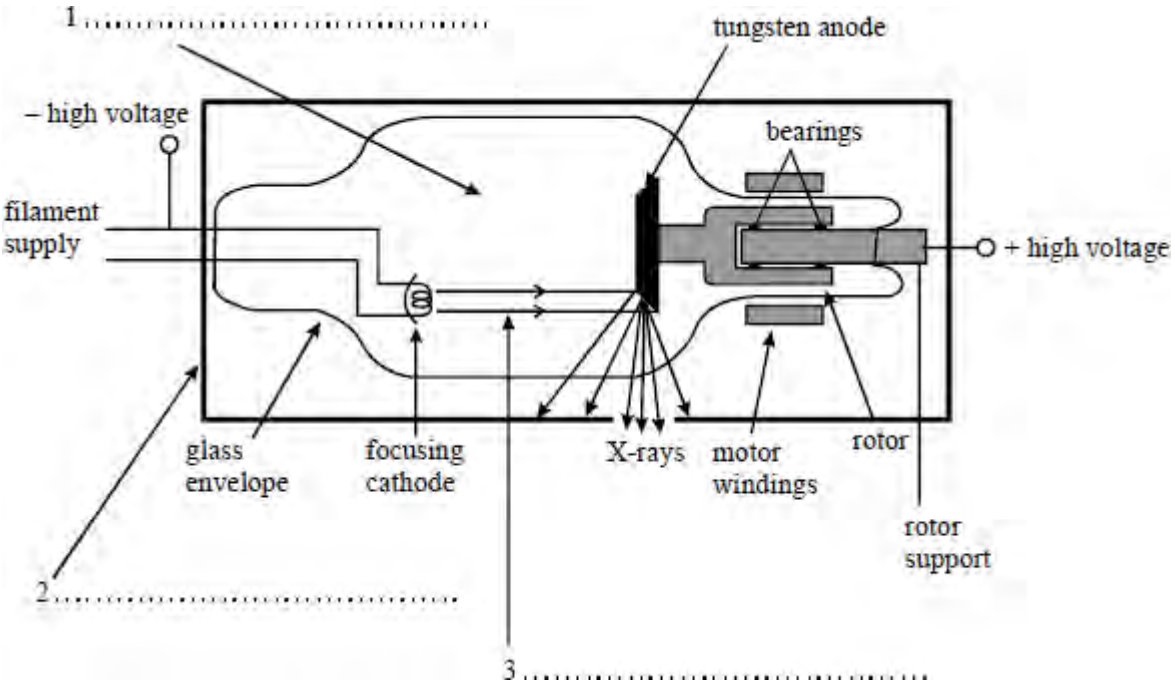
(3)
(Total 6 marks)

Q4.(a) The diagram shows a rotating-anode X-ray tube. Complete the labelling of the **three** numbered arrows in the diagram.



(3)

(b) Explain why the anode

(i) is rotated,

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(ii) has a bevelled edge.

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(3)

(c) Define for a material,

(i) the linear attenuation coefficient, μ,

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(ii) the half-value thickness.

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(2)

(d) A monochromatic X-ray beam of intensity 6.0 W m^{-2} is incident on an aluminium sheet of thickness 2.0 mm. For these X-rays, the half-value thickness of aluminium is 3.2 mm. Calculate the intensity of the transmitted beam.

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(3)
(Total 11 marks)