MEDICAL PHYSICS

6-2 Radiation Therapy

1. electron accelerator operating at 4 MeV = 4×10^6 eV
1 eV = 1.6×10^{-19} J
4 MeV = $4 \times 10^6 \times 1.6 \times 10^{-19} = 6.4 \times 10^{-13}$ J

$h = 6.63 \times 10^{-34}$ Js, $c = 3.00 \times 10^8$ ms^{-1}

(a) $E = hf$, $c = f\lambda$, so $f = \frac{c}{\lambda}$

Substituting for f in E = hf,

$E = \frac{hc}{\lambda}$ therefore $\lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3.00 \times 10^8}{6.4 \times 10^{-13}}$ $= 3.1078.... \times 10^{-13}$ m

$= 3.1 \times 10^{-13}$ m

(b) lead thickness, $x = 12$ mm $= 12 \times 10^{-3}$ m, transmitted intensity = 80% of the original

Original intensity = I_0, transmitted intensity = $I = 0.80I_0$

$I = I_0 e^{-\mu x}$ therefore $\frac{I}{I_0} = e^{-\mu x}$

$\frac{0.80I_0}{I_0} = e^{-(\mu \times 12 \times 10^{-3})}$

$0.80 = e^{-(\mu \times 12 \times 10^{-3})}$

$\ln(0.80) = -(\mu \times 12 \times 10^{-3})$

$-0.22314... = -(\mu \times 12 \times 10^{-3})$

$\mu = \frac{-0.22314...}{12 \times 10^{-3}}$

$x_{1/2} = \frac{\ln 2}{\mu}$ therefore $\mu = \frac{\ln 2}{x_{1/2}} = \frac{\ln 2}{15 \times 10^{-3}}$

$= 46.2....$

$= 46$ m^{-1}