113379469
Prithviraj Kadiyala
kadi0000.

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Homework #1.

1. The range of diagnostic X-Ray
   In terms of nm : (0.062nm — 0.00827nm).
   In terms of energy : (20 keV — 150 keV.)
   In terms of Frequency : (0.48×10^{15} Hz — 3.63×10^{15} Hz)

2. Given :
   E = 20keV.
   Thickness = 6cm or 6×10^{-2} m.
   speed = 3×10^{8} m/s.

   So, Total time taken to travel

   $$= \frac{\text{total distance}}{\text{total speed}}$$

   $$= \frac{6 \times 10^{-2} \cancel{m}}{3 \times 10^{8} \cancel{m}/s}$$

   $$= 2 \times 10^{-10} \text{ s}.$$

   = ~~2ns~~. = 20ns

While subjecting a material to X-Ray.

In Radiography, the rays tend to pass through some material and depending on the different MASS Attenuation co-efficient of the material. Some of the light (Rays) don't make it through the matter, resulting in shadows.

The specialized film is developed to capture the shadow produced in this case.

Photography on the other hand is reflective or scattered photon capturing.

Photography captures photons while radiography captures abscense of photons.

While performing radiography, due to the differential attenuation of the material or in our case human body absorbs some of the radiation and also reflects back some of the radiation causing loss of electrons at the capturing screen.

Scanned by CamScanner

4. Given :

MAC = $0.35 \ cm^2/g = \left(\frac{\mu}{\rho}\right)$.

$x = ?$ for HVL.

$N = N_0 \times e^{-\mu \times x}$.

$\cancel{\frac{1}{2} = e^{-\mu \times x}}$.

$\rho = 1 \ g/cm^3$.

$\mu = MAC \times \rho$

$= 0.35 \ cm^2/g \times 1 \ g/cm^3$

$= 0.35 \ cm^{-1}$

$N = N_0 \times e^{-\mu \times x}$

$\frac{N}{N_0} = e^{-\mu \times x}$

$\frac{1}{2} = e^{-(0.35) \times x}$

$\ln\left(\frac{1}{2}\right) = -0.35 \times x$

$x = \frac{-0.693}{-0.35}$

$x = 1.98 \ cm$.

The material thickness required to reduce an incident beam intensity by a factor of two is $\underline{\underline{1.98 cm}}$

At a specific X-Ray potential of 80kV, two exposures are taken and the radiation dose is measured. Then we place the aluminium sheet in the beam's way and then measure the radiation dose. We start with the minimum amount or thickness of the aluminium sheets and slowly increasing the thickness as the results are required. In this case, at some point we are going to lesser dose than required. At this point we're sure that the HVL point lies between the last placed aluminium sheet and the recently placed aluminium sheet. Then we can go by inserting/Removing the aluminium sheets as required for achieving the desired Half Value Layer.

If an X-Ray machine generates 32kVp. and we have a slab of Lucite and a ruler and a meter than measures x-ray ~~exposure~~ exposure in terms of mR.

Firstly, we would measure the mR with and without placing the slab of Lutice. We can know the density of Lutice by some means.

Then, we can measure the thickness of the slab with the given ruler. So, we now have values N, N_0 and x that denote No of transmitted photons, No of incident photons and absorber thickness respectively.

So, using the formula

$$N = N_0 \times e^{-\mu x}$$

we can find the Linear Attenuation Co-efficient of the Lucite

7\. At 60kVp, $N_1 \propto (60kVp)^2 \times 120mA \times 0.1s$

At 100kVp, $N_2 \propto (100kVp)^2 \times 50mA \times 0.1s$.

$N_1 = 120{,}000$.

$N_2 = ?$

$$\frac{N_1}{N_2} = \left(\frac{60}{100}\right)^2 \times \frac{12\cancel{0}}{5\cancel{0}} \times \frac{\cancel{0.1}}{\cancel{0.1}}$$

$$\frac{N_1}{N_2} = \frac{36\cancel{00} \times 12}{50\cancel{00}00} = \frac{36 \times 12}{500} = \cancel{86.4}\ 0.864$$

$$\frac{N_2}{N_1} = 1.157 = \frac{1}{0.864}.$$

$\therefore N_2 = 1.157 \times N_1$

$N_2 = 1.157 \times 120{,}000$

$N_2 = 138{,}888.88$

$$\boxed{N_2 = 138{,}888.88}$$

$A_1 = \Phi_1 = 2.4 \times 10^8$ photons/m^2

$d_1 = 0.3m$

$d_2 = 1.0m.$

$\Phi_2 = ?$

$$\Phi_2 = \frac{d_1^2}{d_2^2} \times \Phi_1$$

$$= \frac{0.3^2}{1^2} \times 2.4 \times 10^8$$

$$= 0.09 \times 2.4 \times 10^8$$

$\Phi_2 = 0.216 \times 10^8$ photons/m^2

$\therefore$ The fluence at $A_2 = 0.216 \times 10^8$ photons/m^2