Question #62662 - Physics - Atomic and Nuclear Physics

Calculate how thick an absorber needs to be absorbed half of the incoming light.

Solution.

Attenuation coefficient of the volume of a material characterizes how easily it can be penetrated by a beam of light. A large attenuation coefficient means that the beam is quickly "attenuated" (weakened) as it passes through the medium, and a small attenuation coefficient means that the medium is relatively transparent to the beam. The SI unit of attenuation coefficient is the reciprocal metre (m−1). It is defined as

$$\mu = -\frac{1}{\Phi}\frac{d\Phi}{dz},$$

where Φ is the radiant flux, z is the path length of the beam. This differential equation gives a solution:

$$\Phi = \Phi_0 e^{-\mu z}.$$

If a half of incoming light was absorbed, then

$$\Phi = \frac{1}{2}\Phi_0 \to \frac{1}{2}\Phi_0 = \Phi_0 e^{-\mu z} \Longrightarrow \frac{1}{2} = e^{-\mu z} \Longrightarrow \mu z = \ln 2 \Longrightarrow z = \frac{\ln 2}{\mu}.$$

Answer: if absorber has an attenuation coefficient equals μ, its thickness for absorbing half of the incoming light should be $z = \frac{\ln 2}{\mu}$.