

Ch. 9

9-4 A photon with momentum of $211.4 \text{ MeV}/c$ produces muon and anti muon with negligible kinetic energy.

- What happens to the photon? The energy of the photon "becomes" the mc^2 energy of the two particles.
- What is the rest mass of a muon based on info given.

$$E_{\text{photon}} = pc = 2m_0c^2$$

$$m_0 = 105.7 \text{ MeV}/c^2$$

- Are there other particles---

There must be other, in order to conserve both energy and momentum. Something carries away the missing momentum.

9-13 Absorption pressure. How radiation pressure is I/c for absorption, and $2I/c$ for reflection.

$$p_{\text{ph}} = E/c = h\nu/c$$

$$\bar{F} = \frac{\Delta p}{\Delta t} = \frac{h\nu}{c} \times \frac{\# \text{ Photos}}{s}$$

$$\text{Pressure} = \frac{F}{A} = \left(\frac{h\nu}{c} \times \frac{\#}{s} \right) \frac{1}{A} = \frac{I}{c}$$

for reflection

— DOUBLE

9-15 Absorb 90% of intensity in 1.00cm. Find abs coeff

$$\frac{I(\Delta x = 1.00 \text{ cm})}{I_0} = 0.1 \quad \text{given}$$

$$0.1 = e^{-\mu x}$$

$$\ln(0.1) = -\mu x$$

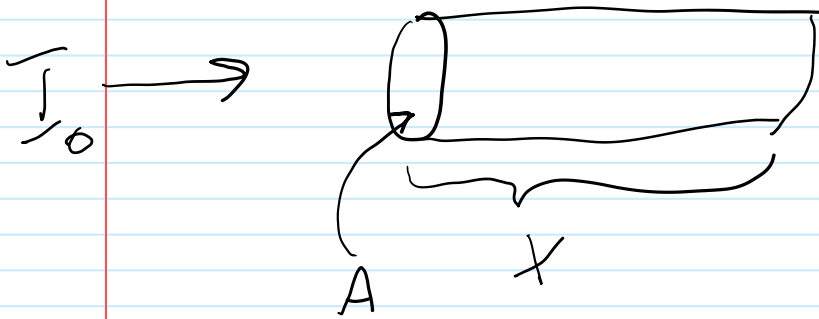
$$\mu = 2.302 / \text{cm}$$

of $1/e$'s
per cm

$$= 230.2 / \text{m}$$

9-16 Determine maximum rise in temp of material due to absorption (so max=assume full thermalization rather than energy scattered away). Given I_0 , abs coeff, length x , area, density and specific heat.

I_0, μ, x, A, ρ, c ← specific heat



Energy enters
Left at rate -
Leaves right

Rate of thermal energy in

$$I_0 A - I_0 e^{-\mu x} A$$

$$= mc \frac{dT}{dt}$$

Net flow in

$$= (\rho A x) c \frac{dT}{dt}$$

This all assumes that the rise in temperature also does not lead to any additional blackbody radiation, so the object is perfectly shiny reflecting.

Solve
$$\frac{dT}{dt} = \frac{I_0 (1 - e^{-\mu x})}{\rho x c}$$

9-27 Given 300 photons per second, each with only 75 % of energy needed to create a electron positron pair, the absorption coef is 20 /m. What is transmitted photon intensity through 3.00cm material.

$$\begin{aligned}h\nu &= 0.75 * 2m_0c^2 \\ &= 0.75 * 0.511 \text{ MeV} * 2 \\ &= 0.7665 \text{ MeV}\end{aligned}$$

$$\underline{I}_0 = h\nu * \frac{300}{\text{m}^2 \text{ s}} = 229.95 \frac{\text{MeV}}{\text{m}^2 \text{ s}}$$

$$\underline{I}_{\text{trans}} = \underline{I}_0 e^{-20 * 0.03} = 126.2 \frac{\text{MeV}}{\text{m}^2 \text{ s}}$$