

# PH-214 Homework 3

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## Problem 1

$$\begin{aligned} \text{Mass of Electron: } 9.11 * 10^{-31} \text{ kg} \quad \text{Mass of Proton: } 1.67 * 10^{-27} \text{ kg} \\ r_e = \frac{q^2}{4\pi\epsilon_0 m_e c^2} = \frac{(1.6 * 10^{-19})^2}{4\pi * (8.85 * 10^{-12}) * (9.11 * 10^{-31}) * (3 * 10^8)^2} = 2.81 * 10^{-15} \\ \sigma_{\text{Th}} = \frac{8\pi}{3} (r_e)^2 = \boxed{6.6 * 10^{-29} \text{ m}^2} \\ r_p = \frac{q^2}{4\pi\epsilon_0 m_p c^2} = \frac{(1.6 * 10^{-19})^2}{4\pi * (8.85 * 10^{-12}) * (1.67 * 10^{-27}) * (3 * 10^8)^2} = 1.53 * 10^{-18} \\ \sigma_{\text{Th}} = \frac{8\pi}{3} (r_p)^2 = \boxed{1.97 * 10^{-15} \text{ m}^2} \end{aligned}$$

## Problem 2

$$\begin{aligned} \epsilon_0 = \frac{\text{C}^2}{\text{N} \cdot \text{m}^2} \quad q = \text{C} \quad c = \frac{\text{m}}{\text{s}} \quad m = \text{kg} \\ \sigma_{\text{Th}} = \frac{8\pi}{3} \left( \frac{q^2}{4\pi\epsilon_0 m c^2} \right)^2 = \left( \frac{\text{C}^2}{\frac{\text{C}^2}{\text{N} \cdot \text{m}^2} * \text{kg} * \frac{\text{m}^2}{\text{s}^2}} \right)^2 = \left( \frac{\text{C}^2}{\frac{\text{C}^2}{\text{kg} \cdot \frac{\text{m}}{\text{s}^2} \cdot \text{m}^2} * \text{kg} * \frac{\text{m}^2}{\text{s}^2}} \right)^2 = \boxed{\text{m}^2} \end{aligned}$$

## Problem 3

$$\begin{aligned} |\vec{S}| = \epsilon_0 * c * |\vec{E}_0|^2 \\ 1.38 * 10^3 = 8.85 * 10^{-12} * 3 * 10^8 * |\vec{E}_0|^2 \\ \vec{E}_0 = \sqrt{\frac{1.38 * 10^3}{8.85 * 10^{-12} * 3 * 10^8}} = \boxed{720.95 \text{ V/m}} \\ \vec{B}_0 = \frac{\vec{E}_0}{c} = \boxed{2.4 * 10^{-6} \text{ T}} \end{aligned}$$

## Problem 4

$$\begin{aligned} |\vec{S}| = \epsilon_0 * c * |\vec{E}_0|^2 \\ 14 * 10^6 = 8.85 * 10^{-12} * 3 * 10^8 * |\vec{E}_0|^2 \\ \vec{E}_0 = \sqrt{\frac{14 * 10^6}{8.85 * 10^{-12} * 3 * 10^8}} = \boxed{7.26 * 10^4 \text{ V/m}} \\ \text{Reflected: } \vec{E}_0 = \sqrt{\frac{14 * 10^6 * 0.75}{8.85 * 10^{-12} * 3 * 10^8}} = 62887.21 \text{ V/m} \quad \vec{B}_0 = \frac{\vec{E}_0}{c} = \boxed{2.09 * 10^{-4} \text{ T}} \end{aligned}$$