HW 2.1 $\Delta U = N_{ph} \cdot \langle E_{ph} \rangle$

A) $N_{ph} = \alpha \gamma 2\pi$ (2.29)

$E = \hbar \omega$, $\omega_c = \dfrac{3\gamma^3 c}{2\rho}$ (2.25)

$$E_{ph} = \frac{\hbar 3 \gamma^3 c}{2\rho}$$

$$\boxed{\Delta U = \alpha \gamma \cancel{2} \pi \left(\frac{\hbar 3 \gamma^3 c}{\cancel{2} \rho} \right) = \frac{3 \alpha \gamma^4 c \hbar}{\rho}}$$

$$U = \frac{4\pi}{3} \alpha \beta^3 \gamma^4 \frac{\hbar c}{\rho}$$ $\boxed{\gamma >> 1 \Rightarrow \beta \approx 1}$

$$\boxed{U = \frac{4}{3} \pi \alpha \gamma^4 \frac{\hbar c}{\rho}}$$

B) $M_p = 938$ MeV $M_e = .511$ MeV

$\gamma_p = \left(\dfrac{7e12}{938e^6} \right) \approx 7.5 e^3$ $\gamma_e = \left(\dfrac{7e^{12}}{.511e^6} \right) \approx 1.37 e^7$

$E \propto \gamma^4$

$\gamma_p^4 \approx 3.2 e^{15}$ $\gamma_e^4 \approx 3.5 e^{28}$

$\sim 10^{13}$ more energy/power radiated by electrons