

1.

(a)

$$\begin{aligned}\frac{dW_{rad}}{dt'} &= \frac{e^2}{4\pi\epsilon_0} \frac{2}{3c} \gamma^6 (\Omega^2 \beta^2 - \Omega^2 \beta^4) \\ &= \frac{e^2}{4\pi\epsilon_0} \frac{2}{3c} \gamma^4 \Omega^2 \beta^2 \\ &= \frac{e^2}{4\pi\epsilon_0} \frac{2\omega_0^2}{3c} \gamma^2 \beta^2\end{aligned}$$

(b)

$$\begin{aligned}\frac{d\gamma}{dt} mc^2 &= - \frac{e^2}{4\pi\epsilon_0} \frac{2\omega_0^2}{3c} \gamma^2 \beta^2 \\ \frac{d\gamma}{dt} &= - \frac{e^2}{4\pi\epsilon_0} \frac{2\omega_0^2}{3mc^3} \gamma^2 \beta^2 \\ &= - \frac{2\omega_0^2 r_e}{3c} \gamma^2 \beta^2 \\ T_0 &= \frac{3c}{2\omega_0^2 r_e}\end{aligned}$$

(c)

For $\gamma \gg 1$, $\beta \approx 1$

$$\begin{aligned}\frac{d\gamma}{dt} &= - \frac{\gamma^2}{T_0} \\ \frac{1}{\gamma} &= \frac{1}{\gamma_0} + \frac{t}{T_0} \\ T &= \frac{\gamma_0 - \gamma}{\gamma\gamma_0} T_0\end{aligned}$$

(d)

$$\begin{aligned}\omega_{break} &= 3\gamma_e^2 \omega_0 \\ \gamma_e &= \sqrt{\frac{\omega_{break}}{3\omega_0}}\end{aligned}$$

(e)

$$\begin{aligned}T &= \frac{T_0}{\gamma} \\ &= T_0 \sqrt{\frac{3\omega_0}{\omega_{break}}}\end{aligned}$$

(f)

$$\begin{aligned}\omega_0 &= \frac{eB}{m} \\ &= 1.76 \cdot 10^3 \\ T &= \frac{3c}{2\omega_0^2 r_e} \sqrt{\frac{3\omega_0}{\omega_{break}}} \\ &= 5.16 \cdot 10^{10} s \\ &= 1635 \text{a}\end{aligned}$$

2.

(a)

(b)

3.

(a)

(b)

(c)

(d)

(e)

4.

(a)

(b)

(c)