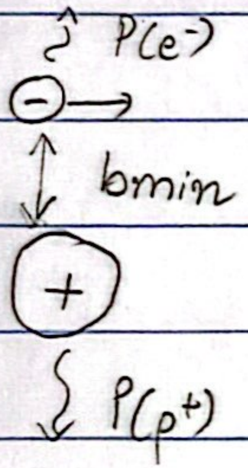
HW 18, 19

19.



$$P = \frac{2}{3} q^2 \frac{a^2}{c^3}$$ (same charge & constants for e^- & p^+) $\Rightarrow \frac{P(e^-)}{P(p^+)} = \frac{a_{e^-}^2}{a_{p^+}^2} = \frac{F^2/m_{e^-}^2}{F^2/m_{p^+}^2}$

Same Columb force $\Rightarrow \frac{P(e^-)}{P(p^+)} = \frac{m_p^2}{m_e^2} \approx 1836^2 \approx 3370896$

$\Rightarrow$ The energy electron radiated dominate proton (3 million times more!)

18. $U = \frac{-q^2}{r}$; $q = 4.803 \cdot 10^{-10}$ StatC ; $t = ?$

$E = T + U = -U/2 + U$ (virial theorem) $= \frac{U}{2} = \frac{-q^2}{2r}$

$\Rightarrow \frac{E}{P} = t$ (power is E/t)

$P \hookrightarrow$ ($p<0$) since the electron is losing energy

$$\begin{cases} P = \frac{-2}{3} \frac{q^2 a^2}{c^3} = \frac{-2q^2}{3c^3} \frac{q^4}{m^2 r^4} = \frac{-2q^6}{3c^3 m^2} \cdot \frac{1}{r^4} \\ \frac{dE}{dt} = \frac{-q^2}{2} \frac{d}{dt}\left(\frac{1}{r}\right) = \frac{+q^2}{2r^2} \frac{dr}{dt} \end{cases}$$

$\boxed{a = \frac{F}{m} = \frac{q^2}{mr^2}}$

$\Rightarrow P = \frac{dE}{dt} \Leftrightarrow \frac{-2q^6}{3c^3 m^2} \frac{1}{r^4} = \frac{+q^2}{2r^2} \frac{dr}{dt}$

Initial Condition: $r(0) = 5.29 \cdot 10^{-9}$ cm

$\Rightarrow \int \frac{4q^4}{3c^2 m^2} dt = -\int r^2 dr \Leftrightarrow \frac{4q^4}{3c^3 m^2} t = -\frac{r^3}{3} + C$

$\Rightarrow C = \frac{r_0^3}{3}$ (at $t=0$) $\Rightarrow t\big|_{r=0} = \frac{r_0^3}{3} \cdot \frac{3c^3 m^2}{4q^4} \approx \boxed{15.5 \text{ ps}}$