Optics - Electromagnetic wave - Accelerated charge

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Light is an electromagnetic wave. The source of this wave is accelerating charges. Calculate the wavelength of the radiation emitted from an electron shaken up and down 3 meters every femtosecond.

Solution: Using the vacuum dispersion relation we can calculate the wavelength,

$$c = \lambda \nu$$

$$\lambda = \frac{c}{\nu} = \frac{3 \cdot 10^8 \frac{\mathrm{m}}{\mathrm{s}}}{1 \cdot 10^{15} \mathrm{s}^{-1}} = 3 \cdot 10^{-7} \mathrm{m}$$

Is it visible?

No, but it is close. It is in the infrared range.

What is the amount of power radiated?

Use the Larmor formula for radiated power.

$$P = \frac{\mu_0 e^2 a^2}{6\pi c}$$

we get the acceleration from harmonic analysis. The maximum acceleration is $a = A\omega^2$, where $A = 3\mathrm{m}$ and $\omega = 2\pi 1 \cdot 10^{15} \mathrm{s}^{-1}$.

$$P = \frac{\left(4\pi \cdot 10^{-7} \frac{\mathrm{H}}{\mathrm{m}}\right) \left(1.602 \cdot 10^{-19} \mathrm{C}\right)^2 \left(3\mathrm{m} \cdot \left(2\pi 1 \cdot 10^{15} \mathrm{s}^{-1}\right)^2\right)^2}{6\pi \left(3 \cdot 10^8 \frac{\mathrm{m}}{\mathrm{s}}\right)} = 8 \cdot 10^{10} \frac{\mathrm{J}}{\mathrm{s}}$$