Problem.
A small oscillating electric dipole, whose size is much less than the wavelength of the emitted radiation, is aligned along the $z$ axis and emits a total power of $1\text{ kW}$. In the horizontal plane at a distance $1\text{ km}$ away (in the radiation zone) is a receiving dish antenna that can capture all the incoming radiation in circle of radius $1\text{ m}$. Find the power received by this antenna.

Hint: You may wish to use Griffiths (11.21) and (11.22) for the cycle-averaged Poynting vector and total power:

$$\langle S \rangle = \left( \frac{\mu_0 p_0^2 \omega^4}{32 \pi^2 c} \right) \frac{\sin^2 \theta}{r^2} \hat{r} \quad \langle P \rangle = \frac{\mu_0 p_0^2 \omega^4}{12 \pi c}$$

Evidently

$$I(\Theta) = |\langle S \rangle| = \frac{3}{8\pi} \langle P \rangle \frac{\sin^2 \Theta}{r^2}$$

We set $\Theta = \pi/2$: $I_0 = I(\Theta = \pi/2) = \frac{3}{8\pi} \langle P \rangle \frac{\pi a^2}{r^2}$

$$P_{\text{receive}} = \frac{3}{8\pi} \frac{\langle P \rangle}{r^2} \pi a^2$$

$$= \frac{3}{8} \frac{a^2}{r^2} \langle P \rangle$$

$$= \frac{3}{8} \left( \frac{1\text{ m}}{1\text{ km}} \right)^2 \langle 1\text{ kW} \rangle = \frac{3}{8} \text{ kW}$$