(a) At large distances, the dominant contribution is magnetic dipole radiation. The magnetic moment of the loop varies as

\[ m = (2a)^2 I_0 \cos(\omega t) \hat{z}, \]

and so the vector potential has leading contribution

\[ A(t) = -\frac{\mu_0}{4\pi rc} \hat{r} \times \hat{m}(t - r/c) = -\frac{\mu_0 a^2 I_0 \omega}{\pi rc} \sin(\omega(t - r/c)) (\hat{r} \times \hat{z}) = -\frac{\mu_0 a^2 I_0 \omega}{\pi rc} \sin(\omega(t - r/c)) \sin \theta \hat{\phi}. \]

Thus the electric field is

\[ E = -\partial_t A = -\frac{\mu_0 a^2 I_0 \omega^2}{\pi rc} \cos(\omega(t - r/c)) \sin \theta \hat{\phi}. \]

(b) The Poynting vector is

\[ S = \frac{E \times B}{\mu_0} = \frac{E^2}{\mu_0 c} \hat{r} = \frac{\mu_0 a^4 I_0^2 \omega^4}{\pi^2 r^2 c^3} \cos^2(\omega(t - r/c)) \sin^2(\theta) \hat{r}. \]

Taking the time-average and integrating over all directions, we obtain the total radiated power

\[ P = 4\frac{\mu_0 a^4 I_0^2 \omega^4}{3\pi c^3} \]

where we have used the integral

\[ \int_{S^2} \sin^2 \theta \, d\Omega = \int_{S^2} (x^2 + y^2) \, d\Omega = \frac{2}{3} \int_{S^2} (x^2 + y^2 + z^2) \, d\Omega = \frac{8\pi}{3}. \]

(c) The conducting plane cancels the transverse component of \( E \), which is equivalent to an image loop located at \( z = -2b \) with the opposite current.

Thus the dominant contribution is now magnetic quadrupole radiation. The magnetic quadrupole moment \( Q \) varies as \( \cos(\omega t) \), and the vector potential is proportional to \( \partial_t^2 Q \propto \omega^2 \). It follows that \( E = -\partial_t A \propto \omega^3 \), and thus the Poynting vector is proportional to \( E^2 \propto \omega^6 \).

Hence the total radiated power has an \( \omega^6 \) dependence.