9.31 Fig. P9.31 depicts a half-wave dipole connected to a generator through a matched transmission line. The directivity of the dipole can be modified by placing a reflecting rod a distance d behind the dipole. What would its reflectivity in the forward direction be if:

(a) $d = \lambda/4$,

(b) $d = \lambda/2$.

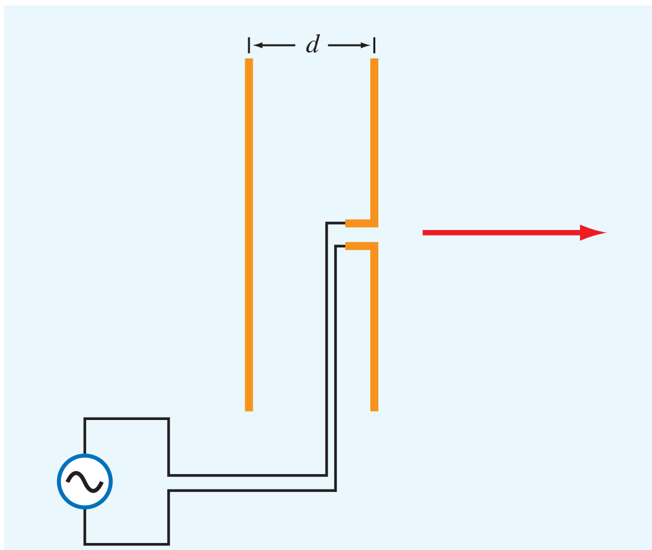
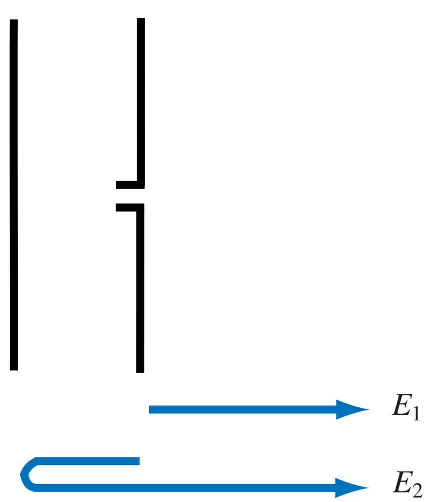


Figure P9.31 Problem 9.31.

Solution: Without the reflecting rod, the directivity of a half-wave dipole is 1.64 (see Eq. (9.47)). When the rod is present, the wave moving in the direction of the arrow consists of two electric field components:



$$E = E_1 + E_2,$$

where E_1 is the field of the radiated wave moving to the right and E_2 is the field that initally moved to the left and then got reflected by the rod. The two are essentially equal in magnitude, but E_2 lags in phase by $2kd$ relative to E_1, and also by π because the reflection coefficient of the metal rod is -1. Hence, we can write E at any point to the right of the antenna as

$$\begin{aligned} E &= E_1 + E_1 e^{j\pi} e^{-j2kd} \\ &= E_1(1 + e^{-j(2kd-\pi)}) \end{aligned}$$

(a) For $d = \lambda/4$, $2kd = 2 \cdot \frac{2\pi}{\lambda} \cdot \frac{\lambda}{4} = \pi$.

$$E = E_1(1 + e^{-j(\pi-\pi)}) = 2E_1.$$

The directivity is proportional to power, or $|E|^2$. Hence, D will increase by a factor of 4 to

$$D = 1.64 \times 4 = 6.56.$$

(b) For $d = \lambda/2$, $2kd = 2\pi$.

$$E = E_1(1 - 1) = 0.$$

Thus, the antenna radiation pattern will have a null in the forward direction.