Problem 9.11 Repeat Problem 9.5 for a 1-m–long half-wave dipole that operates in the FM/TV broadcast band at 150 MHz.

Solution:

(a) Following Example 9-3,

$$\lambda = c/f = (3\times 10^8 \text{ m/s})/(150\times 10^6 \text{ Hz}) = 2 \text{ m}.$$

As $l/\lambda = (1 \text{ m})/(2 \text{ m}) = \frac{1}{2}$, this antenna is a half-wave dipole. Thus, from Eq. (9.48), (9.32), and (9.31),

$$R_{\text{rad}} = 73\ \Omega,$$

$$R_{\text{loss}} = \frac{l}{2\pi a}\sqrt{\frac{\pi f \mu_c}{\sigma_c}} = \frac{1 \text{ m}}{2\pi(10^{-3} \text{ m})}\sqrt{\frac{\pi(150\times 10^6 \text{ Hz})(4\pi\times 10^{-7} \text{ H/m})}{5.8\times 10^7 \text{ S/m}}} = 0.5\ \Omega,$$

$$\xi = \frac{R_{\text{rad}}}{R_{\text{rad}} + R_{\text{loss}}} = \frac{73\ \Omega}{73\ \Omega + 0.5\ \Omega} = 99.3\%.$$

(b) From Eq. (9.47), a half-wave dipole has a directivity of 1.64. The gain, from Eq. (9.29), is $G = \xi D = 0.993\times 1.64 = 1.63 = 2.1$ dB.

(c) From Eq. (9.30a),

$$I_0 = \sqrt{\frac{2P_{\text{rad}}}{R_{\text{rad}}}} = \sqrt{\frac{2(80 \text{ W})}{73\ \Omega}} = 1.48 \text{ A},$$

and from Eq. (9.31),

$$P_t = \frac{P_{\text{rad}}}{\xi} = \frac{80 \text{ W}}{0.993} = 80.4 \text{ W}.$$