2.83 The antenna used at a base station is a $\lambda/2$ dipole which has a *maximum directivity of 2.286 dB*. The power radiated by the $\lambda/2$ dipole is 10 watts. Assume an operating frequency of **1800** MHz:

(a) Determine the *maximum power density* (*in watts/cm*^{2}) radiated by the $\lambda/2$ dipole at a distance of **800** meters.

(b) Assuming the receving antenna used in a mobile unit, such as an automobile, is a $\lambda/4$ monopole, with a *maximum directivity of 5.286 dB*, determine the maximum effective area (*in cm*^{2}) of the monopole antenna.

(c) If the receiving mobile unit, the automobile, is at a distance of **800** meters from the base station, what is the *maximum power* (*in watts*) that can be received by the antenna ($\lambda/4$ monopole), which is mounted on the top of the automobile, and delivered to a matched load/receiver. Assume the antennas are polarization matched, and that there are *no losses* of any kind in both antennas, including no matching/reflection losses.

a) $D_{max} = 2.286 \text{ dB} = 10^{\frac{2.286}{10}} = 1.69278$

Per (2-16a), $D_{max} = \dfrac{4\pi U_{max}}{P_{rad}}$

$\hookrightarrow U_{max} = \dfrac{P_{rad} D_{max}}{4\pi} = \dfrac{1.693(10)}{4\pi} = 1.34707 \text{ W/sr}$

Per (2-12), $U = r^2 W_{rad} \Rightarrow W_{rad,max} = \dfrac{U_{max}}{r^2} = \dfrac{1.34707}{800^2} \dfrac{1 m^2}{100^2 cm^2}$

$W_{rad,max} = 2.1048 \times 10^{-10} \text{ W/cm}^2$

b) Per (2-110), $A_{em} = \dfrac{\lambda^2}{4\pi} D_{max}$ where $\lambda = \dfrac{2.9979 \times 10^8}{1800 \times 10^6}$

$A_{em} = \dfrac{1}{4\pi}\left(\dfrac{2.9979 \times 10^8}{1800 \times 10^6}\right)^2 10^{\frac{5.286}{10}} \dfrac{100^2 cm^2}{1^2 m^2}$

$A_{em} = 74.555 \text{ cm}^2$

c) Per (2-94), $A_e = P_T / W_i \Rightarrow P_T = A_e W_i = P_{rec}$

$P_{rec} = 74.555(2.1048 \times 10^{-10}) \Rightarrow P_{rec} = 15.692 \text{ nW}$