2.106 A rectangular *X*-band horn, with aperture dimensions of 5.5 cm and 7.4 cm and a gain of 16.3 dB (over isotropic) at 10 GHz, is used to transmit and receive energy scattered from a perfectly conducting sphere of radius $a = 5\lambda$. Find the maximum scattered power delivered to the load when the distance between the horn and the sphere is
(a) 200λ (b) 500λ
Assume that the input power is 200 mW, and the radar cross section is equal to the geometrical cross section.

Use (2-126) $\dfrac{P_r}{P_t} = \sigma \dfrac{G_{ot} G_{or}}{4\pi} \left[\dfrac{\lambda}{4\pi R_1 R_2}\right]^2$

where $P_t = 200 \times 10^{-3}\ W$, $\lambda = c/f = \dfrac{2.998 \times 10^8}{10 \times 10^9} = 0.02998\ m$

$\sigma = \pi a^2 = \pi\left[(5)0.02998\right]^2 = 0.07059618\ m^2$

$G_{ot} = G_{or} = 16.3\ dB_i = 10^{16.3/10}$

a) $R_1 = R_2 = 200(0.02998) = 5.996\ m$

$P_r = (200 \times 10^{-3})(0.07059) \dfrac{10^{1.63}\, 10^{1.63}}{4\pi} \left[\dfrac{0.02998}{(4\pi)\, 5.996^2}\right]^2$

$P_r = 9.00265\ nW$

b) $R_1 = R_2 = 500(0.02998) = 14.99\ m$

$P_r = (200 \times 10^{-3})(0.07059) \dfrac{10^{1.63}\, 10^{1.63}}{4\pi} \left[\dfrac{0.02998}{4\pi\, 14.99^2}\right]^2$

$P_r = 0.23047\ nW = 230.468\ pW$