13.46 An L-band pulse radar with a common transmitting and receiving antenna having a directive gain of 3500 operates at 1500 MHz and transmits 200 kW. If an object is 120 km from the radar and its scattering cross section is 8 m^2, find

(a) The magnitude of the incident electric field intensity of the object

(b) The magnitude of the scattered electric field intensity at the radar

(c) The amount of power captured by the object

(d) The power absorbed by the antenna from the scattered wave

a) $\mathcal{P}_{ave,i} = \frac{G_d}{4\pi r^2}\mathcal{P}_{rad} = \frac{3500}{4\pi(120\times10^3)^2}(200\times10^3)$ (13.78)

Chap 10 $\mathcal{P}_{ave,i} = \frac{|E_i|^2}{2\eta_0} \Rightarrow |E_i|^2 = \frac{2(376.7303)3500(200\times10^3)}{4\pi(120\times10^3)^2}$

$$|E_i| = 1.70723 \text{ V/m}$$

b) From (13.77), $\sigma = \lim_{r\to\infty} \frac{4\pi r^2 \mathcal{P}_s}{\mathcal{P}_i}$

$$\hookrightarrow \mathcal{P}_s = \frac{\sigma \mathcal{P}_i}{4\pi r^2} = \frac{\frac{8(3500)200\times10^3}{4\pi(120\times10^3)^2}}{4\pi(120\times10^3)^2} = \frac{|E_s|^2}{2\eta_0}$$

$$1.7101186\times10^{-13} = \frac{|E_s|^2}{2(376.7303)}$$

$$\hookrightarrow |E_s| = 11.3515 \text{ } \mu\text{V/m}$$

c) By defn of RCS (σ)

$$\mathcal{P}_{cap} = \sigma \mathcal{P}_{ave,i} = 8\ \frac{3500(200\times10^3)}{4\pi(120\times10^3)^2}$$

$$\mathcal{P}_{cap} = 0.03095 \text{ W} = 30.9468 \text{ mW}$$

d) Per (13.81) Radar transmission eq'n

$$P_r = \frac{(\lambda G_d)^2 \sigma P_{rad}}{(4\pi)^3 r^4} \quad \text{where } \lambda = c/f = \frac{2.9979 \times 10^8}{1500 \times 10^6} = 0.19986\,m$$

$$= \frac{\left((0.19986)3500\right)^2 8 (200 \times 10^3)}{(4\pi)^3 (120 \times 10^3)^4}$$

$$P_r = 1.9026 \times 10^{-12} W = 1.9026\, pW$$