Problem 12.7: During a particular (and peculiar) rainstorm, each cubic meter of air contains 1000 falling drops, each of identical diameter $D$. (a) Compute the reflectivity factor $Z$, assuming $D = 1$ mm. (b) Repeat for $D = 2$ mm. (c) By what factor did $Z$ increase on account of a mere two-fold increase in $D$? (d) Express your answers to (a)–(c) in units of dBZ. (e) If you replace the liquid raindrops with ice spheres of the same size, by how many dBZ will the radar-estimated effective reflectivity $Z_e$ be reduced? (f) Notwithstanding Eq. (12.41), hailstorms are often recognized on radar displays by virtue of their anomalously high $Z_e$. Why?

$$Z = \int_0^\infty n(D) D^6 \, dD.$$  

for ice, $Z_e \sim 0.2 \, Z$ (eq. 12.41). show where that 0.2 factor comes from.

2. WH 4.42 a and b, for a solar zenith angle of 30 degrees. show how you arrive at your answer.

4.42 Consider solar radiation with a zenith angle of $0^\circ$ that is incident on a layer of aerosols with a single scattering albedo $\omega_0 = 0.85$, an asymmetry factor $g = 0.7$, and an optical thickness $\tau = 0.1$ averaged over the shortwave part of the spectrum. The albedo of the underlying surface is $R_s = 0.15$.

(a) Estimate the fraction of the incident radiation that is backscattered by the aerosol layer in its downward passage through the atmosphere.

Answer: 0.054

(b) Estimate the fraction of the incident radiation that is absorbed by the aerosol layer in its downward passage through the atmosphere.

Answer: 0.014