Homework Assignment #6 = macroscopic electrodynamics
due Friday Oct 11

To aid in grading, for each problem draw a box around your final answers using red pencil.

6-1. (A) Given I = the intensity of a plane electromagnetic wave in empty space, determine equations for E_0 and B_0.
(B) (Numerical) Suppose I = the light intensity from the sun at the surface of the Earth; I = 1360 W / m^2. Calculate the corresponding values of E_0 and B_0 in SI units, for a plane electromagnetic wave. (Of course, sunlight is not a plane wave.)
(C) (Numerical) Continuing part (B), calculate the flux of photons δN/(δt δA) assuming λ = 500 nm.

6-2. Jackson Problem 6-8.

6-3. Jackson Problem 6.11

6-4. Jackson Problem 6.14

6-5. Consider a parallel plate capacitor, capacitance = C. The plates are circular disks (radius a and separation d). The volume between the plates is filled with a dielectric material, permittivity ϵ. The material leaks current, having conductivity g. At time t=0 the charge of the positive plate is Q_0, the potential difference is V_0, and the capacitor is isolated. (A) Find Q(t). (B) Find the *displacement current* in the dielectric. (C) Find the magnetic field in the dielectric. [Neglect fringing fields.]

6-6. A region of space has an electrostatic field and a magneto-static field. (A) Draw a picture (showing sources) such that the Poynting vector is nonzero. (B) Calculate $\oint \vec{S} \cdot \hat{n}$ da for an arbitrary closed surface in the region. (C) Explain.

6-7. Let $\vec{g}$ = momentum density and $\vec{S}$ = energy flux. In classical electrodynamics, $\vec{g} = \vec{S} / c^2$. In quantum theory, light is a stream of photons and again $\vec{g} = \vec{S} / c^2$. Prove that the mass of the photon must be 0.