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—Electromagnetism—

1. Find the Green's function for a rectangular cavity with grounded metal walls having edge lengths of a, b and c.

2. Consider a plane polarized electromagnetic wave, $\vec{E} = \vec{E}_I e^{i(\vec{k}\cdot\vec{x}-\omega t)}$, incident on the plane of interface between two different dielectric media. The media have permeability and permittivity μ_1, ϵ_1 and μ_2, ϵ_2, respectively. (Also, $\rho = 0$, $\vec{j} = 0$ and $\sigma = 0$.)

For the case of the electric field $\vec{E}$ perpendicular to the plane of incidence,

a. state clearly the boundary conditions for $\vec{E}, \vec{B}$.

b. From these conditions, determine all relations between the wave vectors and so derive the well-known laws for relfection and refraction.

c. Determine the relative amplitude of the refracted and reflected waves.

3. An infinite cylinder capacitor consists of two concentric cylinders centered about the z-axis. The radius of the inner cylinder is r_0, and that of the outer one is r_1. The voltage between the cylinders is V. The capacitor is spinning around the z-axis at an angular velocity of ω radians/sec. For each of the three regions (inside the inner sylinder, between the two cylinders and outisde the outer cylinder) find:

a. the electric field $\vec{E}$;

b. the magnetic field $\vec{B}$;

c. the vector potential $\vec{A}$.

4. The Earth is sometimes modeled as an ideal spherical conductor, embedded in an infinte medium of a weak conductor (the air). The conductivity σ and permittivity ϵ of the air are known. Assume that at the time $t = 0$, the Earth is charged with a charge of Q_0 Coulombs. The charge will leak into the atmosphere. Derive:

a. The expression for the charge on the Earth as a function of time for a given Q_0;

b. The Current density in the air as a function of time and position.