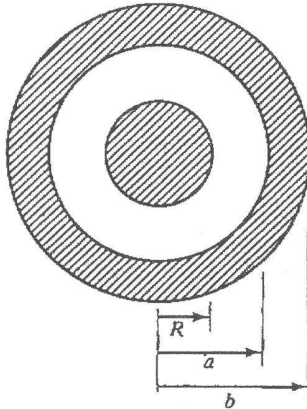
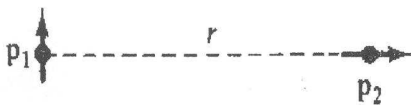


1. A metal sphere of radius R , carrying charge q , is surrounded by a thick concentric metal shell (inner radius a , outer radius b , as figure shown in below). The shell carries no net charge.
 - (a) Find the surface charge density σ : at R , at a , and at b . (6%)
 - (b) Find the electric field $E(r)$ at regions: $r > b$, $a < r < b$, and $R < r < a$. (6%)
 - (c) Find the potential at the center $V(r = 0)$, using infinity as reference. (10%)
 - (d) Now the outer surface is touched to a grounding wire, which lowers its potential to zero (same as at infinity). How do your answer to (a) and (c) change? (8%)



2. As figure shown in below, p_1 and p_2 are dipoles a distance r apart. What is the torque on p_1 due to p_2 ? (10%) What is the torque on p_2 due to p_1 ? (10%)



3. Prove the following:
 - a. An elliptically polarized plane wave can be resolved into right-hand and left-hand circularly polarized waves. (10%)
 - b. A circularly polarized plane wave can be obtained from a superposition of two oppositely directed elliptically polarized waves. (10%)

4. A transparent dielectric coating is applied to fused silica (relative permittivity $\epsilon_r=3.7$, relative permeability $\mu_r=1$) to eliminate the reflection of main peak of solar energy ($\lambda=500$ nm).
- Determine the required dielectric constant and thickness of the coating. (10%)
 - If red light ($\lambda=780$ nm) is shone normally on the coated fused silica, what percentage of the incident power will be reflected? (10%)
5. The permittivity of polymer at optical frequencies is $2.25 \epsilon_0$. It is found that an isotropic light source at a distance d under polymer yields an illuminated circular area of a radius 10 mm (as figure shown in below). Determine d . (10%)

