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PHYS 703 EXAM

December, 2008

1. Consider a hollow conducting sphere of radius a in which a segment subtending an angle α (azimuth) has been insulated from the rest. The segment is maintained at potential V while the remainder is grounded.

   Find:

   (a) The potential $\Phi(0)$ at the center of the sphere.

   (b) The total charge on the sphere (segment and remainder).

   [Hint: If you encounter integrals, do the easy ones and give the difficult ones a label and continue.]

2. A localized distribution of charge has a charge density

$$\rho(r) = \frac{1}{64\pi} r^2 e^{-r} \sin^2\theta$$

   (a) Determine all the nonvanishing multipole moments and write down the potential at large distances as a finite expansion in Legendre polynomials.

   (b) Determine the potential explicitly near the origin, correct to r^2 inclusive.

3. (a) Show that the equation for a magnetic field line due to a magnetic dipole at the origin and oriented along the z-axis is $r = r_0 \sin^2\theta$.

(b) Consider each of the following magnetic fields: $B_0\hat{r}$, $B_0\hat{\phi}$, and $B_0\hat{k}$. In each case explain why such a field is possible or impossible. If the magnetic field is possible, specify a vector potential which gives rise to the field and a current distribution which gives rise to the vector potential.

4. At time $t = 0$ a uniform surface current $\vec{K}_0$ starts to flow along an infinite plane. Find the electric and magnetic fields on both sides of the plane at times $t \geq 0$.

5. An electromagnetic wave is incident on the boundary between two uniform isotropic linear media. Obtain the reflection and transmission coefficients for the case when the electric field is perpendicular to the plane of incidence.