IITK/PHY103 **Problem set-9** **Date: March 6, 2015** [TKG/DpC]

1. Find the vector potential everywhere for

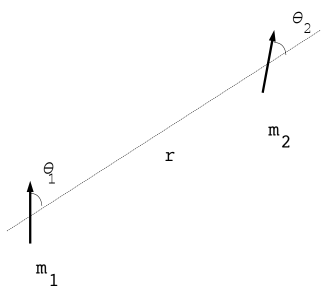
   (a) an infinite uniform surface current $\vec{K} = K\ \hat{i}$, flowing over the x-y plane.

   (b) an infinitely long solenoid of radius R with a constant surface current density K flowing perpendicular to the axis of the solenoid.

2. What current density would produce the vector potential given by $\vec{A} = \mu_0 ks\ \hat{z}$ for $s \leq R$ and $\vec{A} = \mu_0 kR \ln(s)\ \hat{z}$ for $s > R$ in cylindrical coordinates?

3. Find the magnetic dipole moment of a spinning spherical shell of radius R and with surface charge density σ. Show that the vector potential outside the sphere is that of a perfect dipole.

4. Find the work done to bring the two dipoles at a distance r from infinity into the configuration as shown:



Practice problems

1. Find the vector potential inside a wire of radius R if the current I is uniformly distributed in the wire.

2. A dipole $\vec{m} = m_0\hat{k}$ is placed vertically at the origin. Find the surface where magnetic field is horizontal.

3. Consider an infinitesimal square loop to prove that the force law on a magnetic dipole($\vec{m}$) in presence of a magnetic field $\vec{B}$ is given by

$$\vec{F} = \vec{\nabla}(\vec{m} \cdot \vec{B}).$$

   Prove that the electrostatic expressions $\vec{F} = \vec{\nabla}(\ \vec{p}\cdot\ \vec{E})$ and $\vec{F} = (\vec{p}\cdot\vec{\nabla})\vec{E}$ are equivalent. Is this true for the analogous magnetostatic case?