FONDAMENTI DI ELETTRODINAMICA

08/03/2019

ELETTROSTATICA (ESERCIZI DA MACCHI-MORUZZI-PEGORARO)

PROBLEMA 1

In a given region of space we have a static magnetic field, which, in a cylindrical reference frame (r, ϕ, z), is symmetric around the z axis, i.e., is independent of ϕ, and can be written $\mathbf{B} = \mathbf{B}(r, z)$. The field component along z is $B_z(z) = B_0 z/L$, where B_0 and L are constant parameters.

a) Find the radial component B_r close to the z axis.

A particle of magnetic polarizability α (such that it acquires an induced magnetic dipole moment $\mathbf{m} = \alpha\mathbf{B}$ in a magnetic field $\mathbf{B}$), is located close to the z axis.

b) Find the potential energy of the particle in the magnetic field.

c) Discuss the existence of equilibrium positions for the particle, and find the frequency of oscillations for small displacements from equilibrium either along z or r (let M be the mass of the particle).

PROBLEMA 2

A magnetically "hard" cylinder of radius R and height h, with $R \ll h$, carries a uniform magnetization $\mathbf{M}$ parallel to its axis.

a) Show that the volume magnetization current density $\mathbf{J}_\mathrm{m}$ is zero inside the cylinder, while the lateral surface of the cylinder carries a surface magnetization current density $\mathbf{K}_\mathrm{m}$, with $|\mathbf{K}_\mathrm{m}| = |\mathbf{M}|$.

b) Find the magnetic field $\mathbf{B}$ inside and outside the cylinder, at the limit $h \to \infty$.

c) Now consider the opposite case of a "flat" cylinder, i.e., $h \ll R$, and evaluate the magnetic field $\mathbf{B}_0$ at the center of the cylinder.

d) According to the result of **c)**, $\lim_{R/h\to\infty} \mathbf{B}_0 = 0$. Obtain the same result using the equivalent magnetic charge method.

PROBLEMA 3

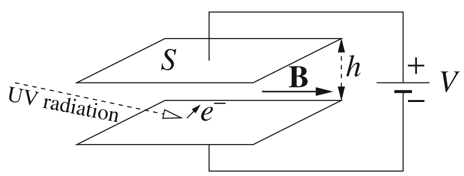

Fig. 5.4

A particle of electric charge q and mass m is initially at rest in the presence of a uniform electric field $\mathbf{E}$ and a uniform magnetic field $\mathbf{B}$, perpendicular to $\mathbf{E}$.

a) Describe the subsequent motion of the particle.

b) Use the above result to discuss the following problem. We have a parallel-plate capacitor with surface S, plate separation h and voltage V, as in Fig. 5.4. A uniform magnetic field $\mathbf{B}$ is applied to the capacitor, perpendicular to the capacitor electric field, i.e., parallel to the plates. Ultraviolet radiation causes the negative plate to emit electrons with zero initial velocity. Evaluate the minimum value of $\mathbf{B}$ for which the electrons cannot reach the positive plate.