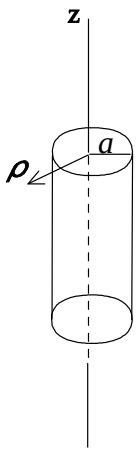
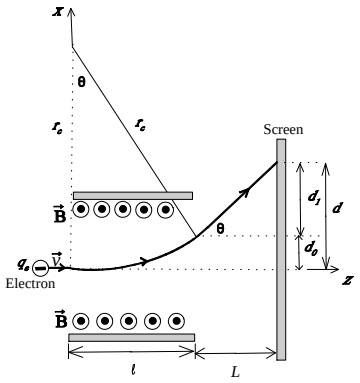
Engineering 6813 Tutorial 3 (Ampère's Law, Lorentz Force, Torque) Fall, 2009

1. A long straight wire of radius a lies along the z axis and carries a uniformly distributed current I. Determine the magnetic field $\vec{H}$ inside and outside the wire. Sketch this field as a function of ρ, the radial distance from the wire.



2. A static magnetic field is being used in a cathode ray tube to deflect an electron beam. The uniform magnetic field $\vec{B} = \hat{y}\, B_0$ between the deflection coils and is assumed to be zero everwhere else. See diagram. Each electron of mass m_e carries a charge q_e and enters the field with a velocity of $\vec{v} = \hat{z}\, v_0$. Determine the deflection d on the screen in terms of the given parameters. (See class notes for the derivation of the radius of the charge path for this example).



3. An infinitely long filamentary conductor located on the z-axis carries a current I in the $\hat{z}$ direction. An identical filament passing through the point $(0, d, 0)$ and parallel to the z-axis carries a current of I also in the $\hat{z}$ direction. Determine the force per unit length which one filament exerts on the other. Is the force attractive or repulsive?

4. A straight solid wire segment carrying a current of $2\hat{y}$ A extends from $A(0, 1, 2)$ to $B(0, 4, 2)$ in free space. This wire is subjected to the magnetic field of an infinite line current filament lying along the z axis and carrying a 25 A current in the $\hat{z}$ direction. Find the vector torque on the wire segment about (a) the origin, (b) $P_A(0, 0, 2)$ and (c) $P_B(0, 2, 0)$.