1 Motion in combined E and B fields. The electric field of magnitude $E$ points in the $z$-direction, and the magnetic field of magnitude $B$ points in the $x$-direction. At time $t = 0$ the particle (of charge $Q$) is at the origin, and has an initial velocity: $\mathbf{v} = -(E/B)\hat{y}$.

(a) Find the trajectory: $(x(t), y(t), z(t))$ for time $t > 0$.

(b) Sketch the trajectory.

2. Show that the total force on a closed circuit carrying a current $I$ in a uniform magnetic field is zero. The circuit is made of thin wires.

3. Computing B A very-long, straight flat conducting sheet of width $2a$ carries a current $I$. The coordinate axes are chosen so that the edges of the conductor are located at $x = \pm a$, and the current flows in the direction of the positive $z$-axis. See the figure. The $y$-axis goes into the page. Hint: you will need to do a surface integral, so consider the quantity $K$.

(a) Compute the magnetic field $\mathbf{B}$ as a function of $x, y$. You may take $z = 0$ because the strip is very long.

(b) Consider points $(x, y) = (D, 0)$ and $(x, y) = (0, D)$ with $D \gg a$. Compare the results with the magnetic field of a long straight wire.

4. Consider the magnetic field of a spinning electrically charged conducting sphere. The sphere is charged to a potential $V$ and spun about a diameter at an angular velocity $\omega$.

(a) Show that the surface current density is $K = \epsilon_0 \omega V \sin \theta$.

(b) Find the magnetic flux density, $B_0$, at the center.

(c) Determine the numerical value of $B_0$ for a sphere .1 m in radius, charged to $10^4$ V, and spinning at 10,000 turns per minute.

(d) What current flowing through a loop .1 m in radius would have the same $B_0$. 

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