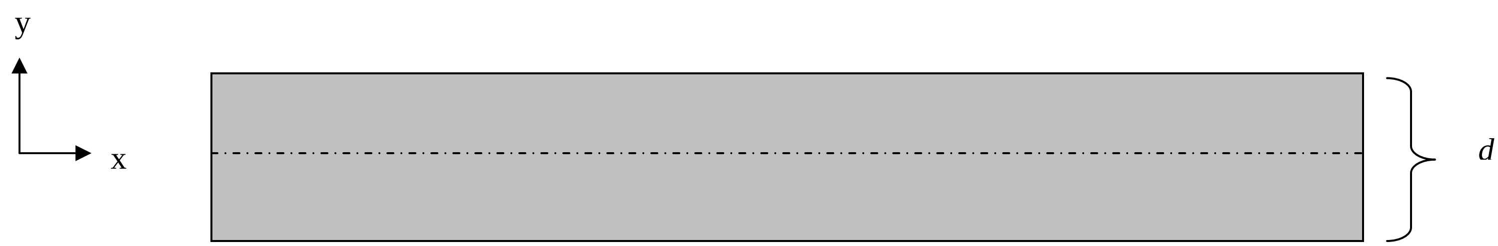
Homework 2:

Remember: In addition to this problem, you also have a "Mastering Physics" assignment Due February 15.

Due at the **beginning** of lecture, Friday, February 15. Write up of the solution to this problem in a coherent fashion.

In class we used Ampere's law to find the magnetic field from a "current sheet" which was large enough to be considered as infinite. In this homework, I want you to consider a "current slab" of thickness *d* carrying a current density of magnitude *J*. You can envision the slab as being in the x-z plane and carrying current in the z direction as in the figure below which gives a cross-sectional view:



You should envision the current coming out of the page and take the extent in the x and z direction to be large enough to be well approximated by infinity. The dashed line in the center of the diagram marks the location, $y=0$.

As with the current sheet example done in class, symmetry considerations require that the field is oriented in (either the positive or negative) x direction with a magnitude independent of x and z. Thus one can write $\vec{B} = \hat{i}B(y)$. Moreover the symmetry of the problem requires $B(y)=-B(-y)$: the field below is of the same magnitude and opposite direction of the analogous point above. Among other things this implies that $B(0)=0$.

a. By choosing an appropriate loop for Ampere's law, find the strength of the magnetic field inside the slab. That is, find $B(y)$ for $d/2>y> -d/2$. *Hint: A rectangular loop including y=0 is helpful.*

b. By choosing an appropriate loop for Ampere's law, find the strength of the magnetic field outside the slab. That is find $B(y)$ for $y> d/2$ and for $y <-d/2$.

c. Show that the result of b. is the same as what one have for a sheet of current at $y=0$ with $\mathscr{J}= Jd$ where $\mathscr{J}$ is a surface current density. (You can use the result obtained in class for comparison.). Why should one expect this result?