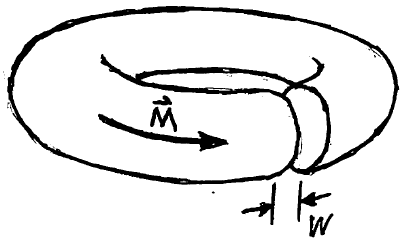
PH632 – Winter 2016
Homework #4
Due Friday Feb 5 at 5pm

1. Magnetized rod

An iron rod of length L has a circular cross-section (radius *a*) and is given a uniform magnetization **M** pointing along its length. The rod is then bent into a circle with a narrow gap (width *w*), as shown in the figure. Find the field at the center of the gap, assuming $w << a << L$.



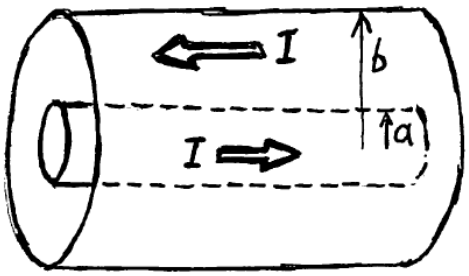
Hint: Map the situation onto one that generates the same B field: a complete toroidal solenoid superimposed with a loop of reverse current.

2. Magnetized sphere

Find the magnetic field inside and outside a solid iron sphere that has uniform magnetization **M**.

3. Fields inside a coaxial cable

A coaxial cable consists of two very long cylindrical tubes, separated by linear insulating material of magnetic susceptibility χ_m. A current *I* flows down the inner tube conductor and returns along the outer one; in each case, the current distributes itself uniformly over the surface. Find the magnetic field in the region between the tubes. As a check, calculate the magnetization and the bound currents, and confirm that (together, of course, with the free currents) they generate the correct field.



4. B-field in current-carrying wire

A current I flows down a long straight wire of radius a. If the wire is made of linear material (such as copper or aluminum) with susceptibility χ_m, and the current is distributed uniformly, what is the magnetic field a distance s from the wire's axis? Find all the bound currents. What is the *net* bound current flowing down the wire?