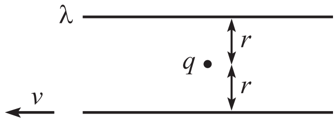
Physics 15b

Problem Set #6 **Due: Thurs, 3/28/13**

1. Exercise 5.11 (Electron beam)
2. Exercise 5.26 (Charges in a wire)
3. Two infinitely long sticks each have uniform linear proper charge density λ. ("Proper" means as measured in the rest frame of the given object.) One stick is stationary in the lab frame, while the other stick moves to the left with speed v, as shown. They are $2r$ apart, and a stationary point charge q lies midway between them. Find the electric and magnetic forces on the charge q in the lab frame, and also in the frame of the bottom stick. (Be sure to specify the directions.) Then verify that the total forces in the two frames relate properly.

   In order to receive full credit, any electric or magnetic force you write down must contain three subscripts/superscripts that label (1) the frame, (2) the type of force (electric or magnetic) and (3) the stick that causes the force.



4. Exercise 6.38 (Uniform field in off-center hole)
5. Exercise 6.44 (Line integral along the axis)

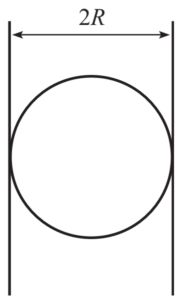
   (To explain why the return path can be ignored, you can wait until we cover the Biot–Savart law on 3/26.)
6. Exercise 6.54 (Force between a wire and a loop)
7. The figure below shows a cross section of an infinite cylinder with radius R extending perpendicular to the page, and an infinite slab with thickness $2R$. The cylinder carries uniform current density $2J$ *out of* the page, and the slab carries uniform current density J *into* the page. In the overlap region (the cylinder), the currents add, so the density is J out of the page.

   (a) Find the magnetic field due to *only* the cylinder, at radius r inside the cylinder. Find it as a function of r, and then write its components in terms of Cartesian coordinates x and y.

   (b) Find the magnetic field due to *only* the slab, for values of x inside the slab. (You will want to consider a wisely chosen Amperian loop.)

   (c) Find the *total* magnetic field due to both the cylinder and the slab, at points inside the cylinder.

   (d) Verify that curl $\mathbf{B} = \mu_0 \mathbf{J}$ inside the cylinder.



8. (Challenge question – you don't need to hand this in, but you should make sure you understand the solution once the solutions are posted):

   Exercise 6.34 (Torque on a loop)