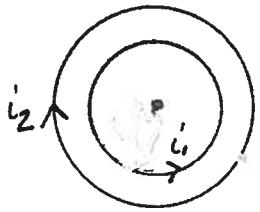
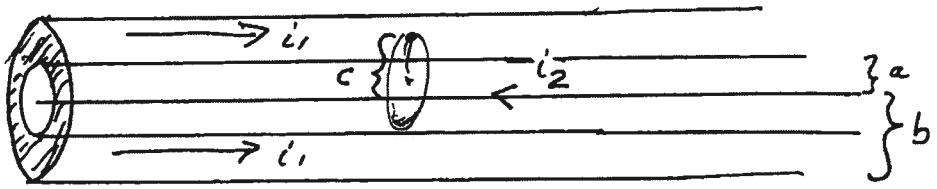
1. (25 points)There are two concentric circular loops of extremely thin wire, one with i_1 and one with $i_2 = 3i_1$, as shown.

a. If the smaller loop has radius a and the larger has radius b, find the magnetic field at the center.



b. How would the radii a and b have to be related in order for there to be no magnetic field at the center?

2. (25 points)Consider an infinitely long, hollow cylindrical wire The wire has outer radius b and the cylindrical hole at its center has radius a. A current i_1 flows from left to right and the current is uniformly spread over the region between a and b. At the center of this wire is a very, very thin wire carrying a current i_2 from right to left.



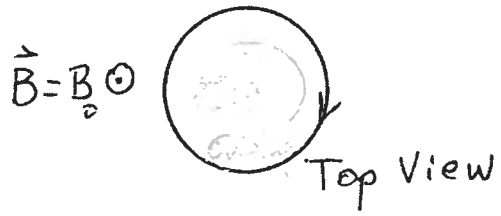
Find the magnetic field at the point a distance c from the center such that the point is between a and b.

3. (25 points)A circular loop of wire has resistance R. It is in the horizontal plane. There is a constant vertical magnetic field of magnitude B_0 pointing up. At time $t = 0$ the loop begins to mysteriously expand so that its radius is given by

$$r(t) = r_0(1 + \beta t)$$

where β is a known constant. (The resistance does not change during this expansion.)

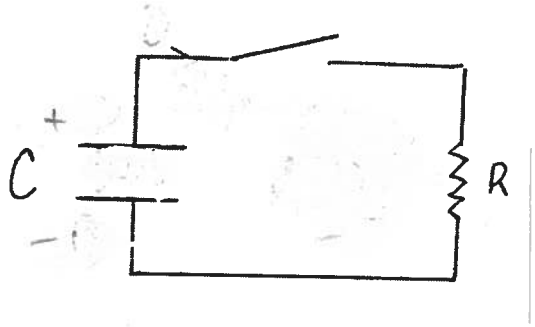
a. Find the current in the loop, including its direction, as a function of time. (Ignoring self inductance.)



b. Find the force that will be exerted on the each segment, $d\vec{s}$, of the loop by the magnetic field.

c. In ten words or less, how does this induced current obey Lenz's Law? Warning: One or more words over the limit of ten means no credit!

4. (25 points)In the circuit below the capacitor is originally charged with Q_0 on the top plate and $-Q_0$ on the bottom. At $t = 0$ the switch is closed.



a. **Derive**, starting with some law, the equation for the charge on the plates as a function of time if the self inductance of the circuit is L.

b. Solve the equation for the charge on the plates as a function of time assuming the resistance R can be ignored. Clearly show your work.