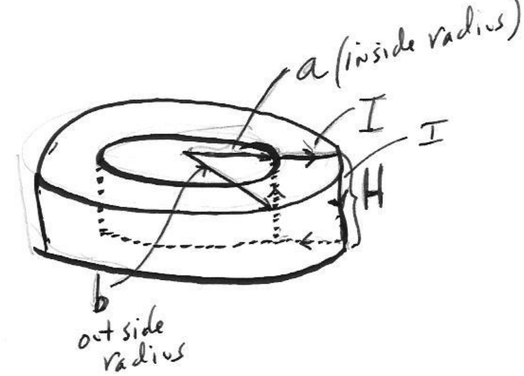
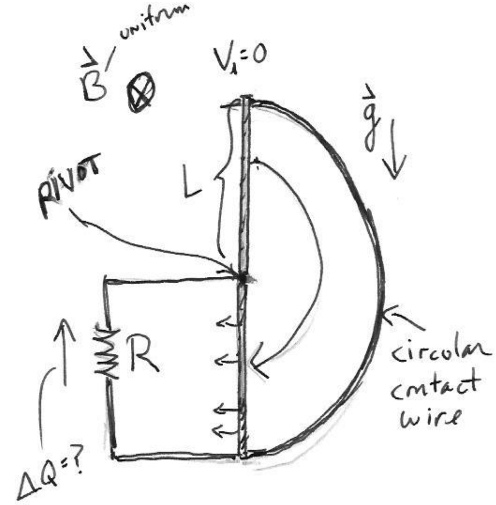
4B Final Exam Spring 2013 Name________________________________

1. (10 points) Duplicating what was done in class. Derive the formula for the impedance, Z, of an LRC series circuit. For full credit, include a phasor diagram to explain your reasoning.

2. (10 points) Refer to the diagram for specific dimensions. Find the total magnetic field energy associated with the rectangular toroid of N turns when there is a current I through it.

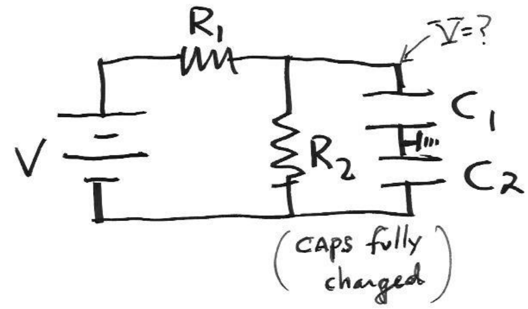


3. (10 points) Refer to the diagram. A conducting bar of length L and mass M is free to pivot at one end is initially at rest in the vertical position as shown. It is constructed to always make a connection and circuit with a resistor R. A magnetic field, B, exists that is perpendicular to the page and uniform. The bar is free to pivot at one end while still making a connection with the circuit. At some moment, gravity causes the bar to swing down to the bottom vertical position (but it would not be at rest in that position). **Find the total charge ΔQ that moves through the resistor between when the moves from the top to the bottom position.** The problem isn't as hard as it sounds.

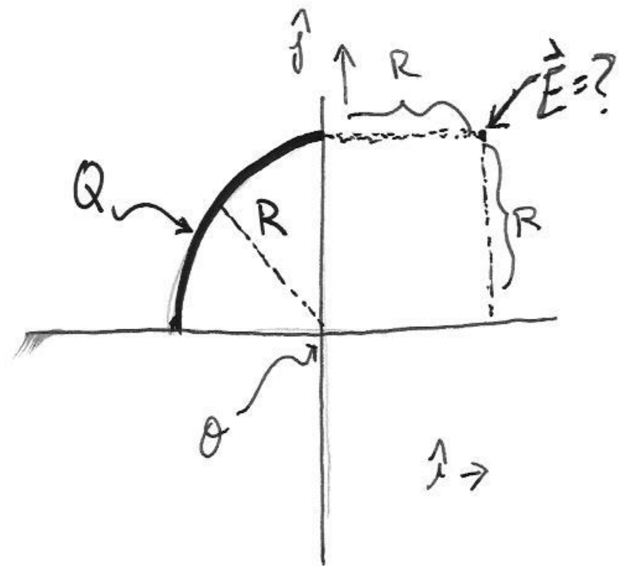


4. (10 points) Two parallel, infinitely straight lines currents, I_1 and I_2, (but opposite in direction) are separated by a distance *d*. Find the magnitude of the force per length between them ("force per length" so that it wouldn't be an infinite force between them). Indicate whether the force would be attractive or repulsive.

5. (10 points) You didn't get a DC circuit on the second exam so here is one to make up for it. Hint: if two capacitors are in series, they must have the same charge. Find the electric potential at the point indicated in the diagram. The capacitors are fully charged.



6. (10 points) Consider the diagram. Find the electric field at the point indicated. A full vector development is expected. Use the coordinate system as shown. Leave the answer ready to integrate.



7. (10 points) A uniformly charged dielectric circular disk of radius *a* contains a total positive charge Q. A bead of positive charge q and mass m is constrained to move along a wire (with no friction present) and slides from the middle of the disk to the edge as shown. **If the bead starts at rest, find its final speed at the edge.**