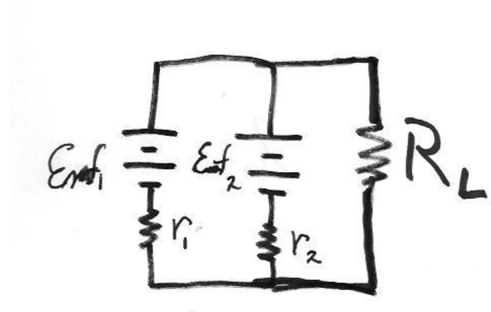
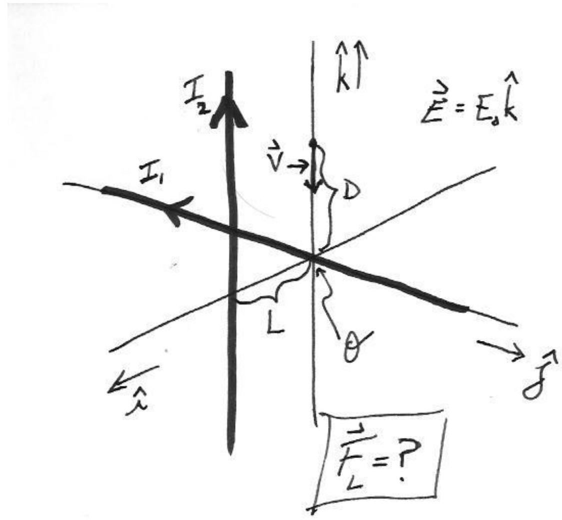
Physics 4B Exam 2   Winter 2012   Name___________________________

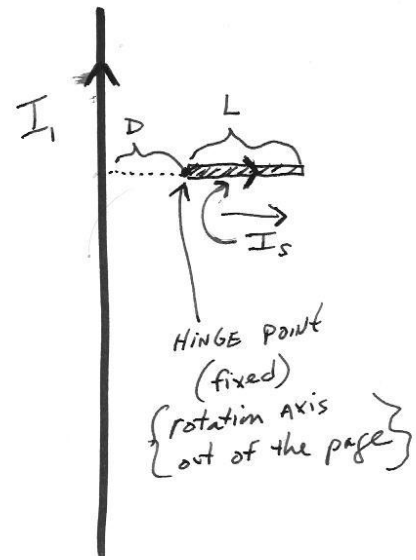
1. (25 points) Consider the circuit in the diagram: two real batteries (of equal Emf, but call them Emf_1 and Emf_2 for identification purposes) are connected in parallel across a single load resistance R_L. But even though their emf's are the same, their internal resistances are *not* the same and are r_1 and r_2. So in this case the current delivered by each battery is not the same. **Find the ratio of the current delivered by Emf_1, I_1 to the total current delivered to R_L, that is, find I_1/I_{total}**. Your final answer will be in terms of the two internal resistances only. At the end of the problem, let $r_2 = 2r_1$ and find the final answer as a purely numerical fraction. This problem does not have to be algebraically difficult.



2. (25 points) Consider the coordinate system shown in the diagram. Two infinite straight lines of current, I_1 and I_2 are arranged as shown. I_1 is on the y axis in the negative direction and I_2 is parallel to the z axis a distance L away from it in the positive direction. There is also a uniform electric field present everywhere given as $\mathbf{E} = E_o\,\mathbf{k}$. A charge, +q, at the shown position has a velocity at that instant of: $\mathbf{V} = -V_z\,\mathbf{k}$. **Find the Lorentz force on this charge at that time.** Your final answer will be in terms of unit vectors. A quick and dirty Ampere's Law is ok here, but fans of the polar form evaluation of the cross product will not find this so easy. In case you're wondering, this is not a "change of frame of reference" problem.



3. (25 points) Consider the arrangement shown in the diagram. An infinite straight line of current, I_1 creates a magnetic field everywhere. A straight line current "segment" of length L (don't worry about how it completes a circuit here) exists as shown, with a current through it of I_S, to the right, where it is hinged and free to rotate about an axis (out of the paper) through the fixed point as indicated in the diagram. **Find the magnitude of the torque from the infinite straight line of current on the segment about the hinge point.** Ampere's Law, quick and dirty, is okay**.** Your final answer can be as an integral completely ready to integrate with limits.



4. (25 points) Referring to the diagram, using the Biot-Savart Law, **find the magnetic field magnitude along the y axis, B(y),** due to the spinning disk of charge. Note there is only charge present from R/2 to R and consider the charge density constant and given as σ (so it would be in your final answer). Say that the disk is spinning with a given angular velocity of ω. Hint: the Biot-Savart Law gives dB in terms of IdL, but in this problem think of dB in terms LdI (dI = dq/T), and L is the circumference of an arbitrary ring of charge. You can make this substitution at the appropriate time. Your final answer is an integral ready to integrate with limits.