Phys 3310, HW #11, Due in class Wed Apr 3

Please read the Extra Credit question first! It may require planning on your part.
NOTE: Thursday Apr 4 is the second exam (7:30-9:15 PM) See our website for details. You may bring BOTH sides of one page of paper with your own hand written notes (I will also provide a cribsheet with the front and back flyleafs of Griffiths. It's on our website)

Q1. MAGNETIC FORCES
A) Griffiths works out (Ex 5.2) the general solution to motion of a particle in "crossed E and B fields" (**E** points in the z-direction, **B** in the x-direction) Work carefully through his solution, make sure you follow it. Then, *use it* to answer the following:
i) Suppose the particle starts at the origin at t=0, with a given velocity $\mathbf{v}(t=0) = v_0 \hat{y}$.

Use Griffiths' formal results (Eq. 5.6) to find the "special initial speed, v_0, whose subsequent motion is simple straight-line constant-speed motion. (Verify that this answer makes sense by using elementary Phys 1120-style right-hand rule arguments and the Lorentz force law)

ii) The discovery of the electron (J.J. Thomson, 1897) used an apparatus with crossed E and B just like the above – he adjusted E until he observed "straight-line, constant-speed" motion of the particle beam. Then, he turned off the E-field, and measured the radius of curvature (R) of the electron beam (deflected purely by the remaining B-field). Given E, B, and R (all measured), deduce Thomson's formula to find the charge to mass ratio (e/m) of the electrons.

B) Go back to Griffiths' Ex 5.2 again, but this time suppose your particle starts at the origin with $\mathbf{v}(t=0) = v'_0 \hat{y}$, with starting speed v_0' exactly HALF the "special value" velocity you found in part i. Find and sketch the resulting trajectory of the particle. Is the kinetic energy of the particle constant with time? Briefly, comment (Is this consistent with energy conservation?!)

Q2. *We are going to be working with "current densities" for the rest of the term. Let's start with a couple simple examples for you to practice with. (More to come!)*
i) A solid cylindrical straight wire (radius a) has a current I flowing down it. If that current is uniformly distributed JUST over the outer surface of the wire (i.e. none is flowing through the "volume" of the wire, it's all surface charge), what is the magnitude of the surface current density, |**K**|?
ii) Suppose that current *does* flow throughout the volume of the wire, but in such a way that the volume current density J grows quadratically with distance from the central axis. What is the formula for **J** everywhere in the wire?
Note that neither situation i nor ii is physically what happens in normal wires!
iii) A DVD has been rubbed so that it has a fixed, constant, uniform surface electric charge density σ everywhere on its top surface. It is spinning at angular velocity ω about its center (which is at the origin). What is the surface current density |**K**| at a distance r from the center?

Extra Credit: (Worth an extra 10% on this week's homework)
Get together with someone from class, invent a practice exam question or two, and share. Try to solve theirs, and discuss with them whether you think they got the level and coverage right. (If you can't find someone in person, use our piazza.com site. Like before, find a question nobody else has responded to!) **To turn in:** Write down the name(s) of the person you worked with. To show us that you really did this activity, paraphrase their question(s). You do NOT have to show us your solution, though, that's for you to talk about with your partner.