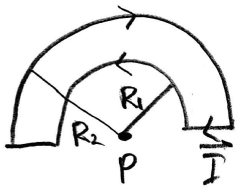
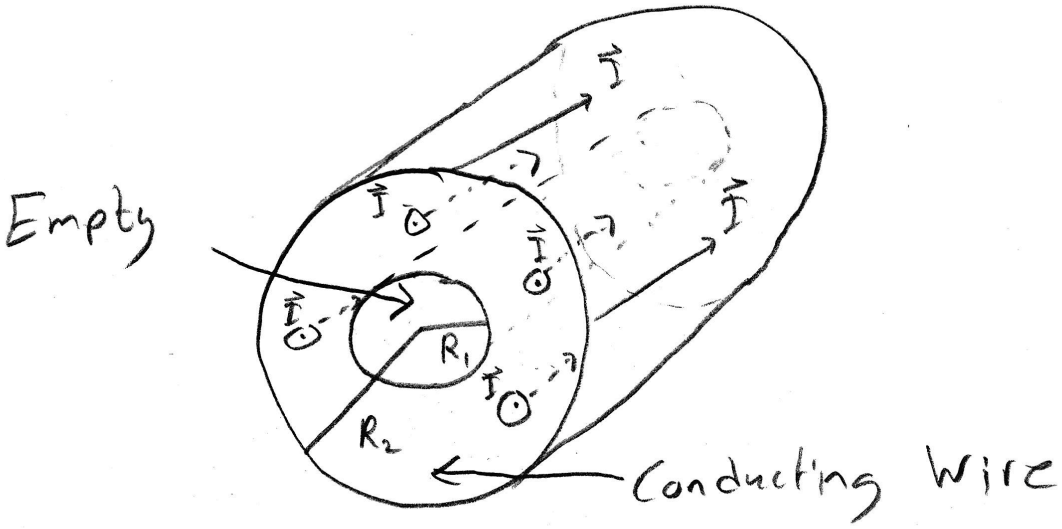
Workshop Module 4

1. A straight piece of conducting wire of mass M and length ℓ is placed on a frictionless incline tilted at an angle θ from the horizontal. The length of the wire is perpendicular to the direction of the incline. There is a uniform, vertical magnetic field $\vec{B}$ up at all points. To keep the wire from sliding down the incline, a voltage source is attached to the ends of the wire. Make a sketch of the problem and appropriate free body diagrams. Determine the magnitude and direction of the current in the wire that will cause the wire to remain at rest (i.e., not slide down the incline).

2. The wire semicircles in the figure below have radii R_1 and R_2. Calculate the net magnetic field $\vec{B}$ (magnitude and direction) at the point P (at the center of the loops) due to the current $\vec{I}$ passing through the loop in the direction shown.



3. A conductor is made in the form of a hollow cylinder with inner and outer radii R_1 and R_2, respectively. It carries a current $\vec{I}$, uniformly distributed over its cross section. Derive expressions for the magnitude of the magnetic field in the regions



   (a) $r < R_1$
   (b) $R_1 < r < R_2$
   (c) $r > R_2$

4. Quickly review the concept of electromagnetic induction. Break up into 2 groups if possible. With your group, create two problems for the rest of the class to figure out ... be tricky! Each group should go to the board and present their problems for the class to discuss.

   Group 1 Should consider two circular loops lying next to each other in a plane. Current of either charge flows with a time-dependence in either direction in one of the loops. What is the direction of the induced current in the other loop?

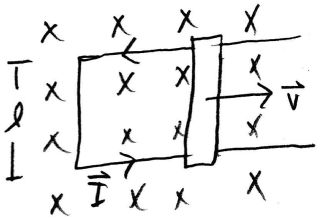
   Group 2 Should do the same ... except the two loops in this case are not in the same plane, rather they are coaxial with one lying near the other ... like two rings on one finger.

5. In the figure below, a rod with length $\ell = .0650m$ moves in a magnetic field with a magnitude $B_0 = 1.20T$. The emf induced in the moving rod is $0.320V$.

   (a) What is the speed of the rod?

   (b) If the total circuit resistance is $.800\Omega$, what is the induced current?

   (c) What force (magnitude and direction) does the field exert on the rod as a result of this current?



6. Two closely wound circular coils have the same number of turns, but one has twice the radius of the other. How are the self-inductances of the two coils related?

7. Watch the video at `7.http://phys23p.sl.psu.edu/phys_anim/EM/indexer_EM.html`. Discuss what you see. can you explain why the current behaves as it does given what the flix is doing?

8. Watch the series of videos at `http://web.mit.edu/8.02t/www/802TEAL3D/visualizations/faraday/inductance/inductance.htm`. After each video stop and discuss. Move on when everyone understands what is going on and can talk about it in terms of things we know about. The third video gets pretty tough, but its still just the stuff we've already done.