IITK/PHY103, **Problem set-11** **Date: March 21, 2015** [DpC/TKG]

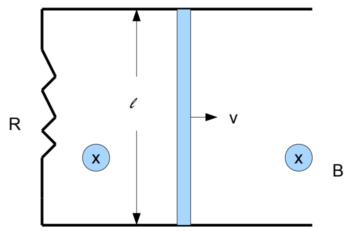
1. A metal bar of mass m slides frictionlessly on two parallel conducting rails a distance l apart. A resistor R is connected across the rails and a uniform magnetic field $\mathbf{B}$, pointing into the page, fills the entire region(as shown in the figure).

   (a) If the bar moves to the right at speed v,what is the current in the resistor? In what direction does it flow?

   (b)What is the magnetic force on the bar? In what direction?

   (c)If the bar starts out with a speed v_0 at time $t = 0$, and is left to slide, what is its speed at a later time t?

   (d) The initial kinetic energy was of course $(1/2)mv_0^2$, check that the energy delivered to the resistor is exactly $(1/2)mv_0^2$.



2. An alternating current $I = I_0 \cos(\omega t)$ flows down a long straight wire and returns along a coaxial conducting tube of radius a.

   (a) In what direction does the electric field point?

   (b) Assuming the field goes to zero at $s \to \infty$, find $\vec{E}(s,t)$.

Practice Problems:

1. Two concentric metal shells of radius a and b, respectively, are separated by weekly conducting material of conductivity σ.

   (a) If they are maintained at a potential difference V, what current will flow from one to the other?

   (b)What is the resistance between the shells?

   (c) If $b >> a$, the outer radius b becomes irrelevant. How do you account for that? What will be the resistance between two identical balls of radius a separated by a large distance?

2. A perfectly conducting spherical shell of radius R rotates about z-axis with angular velocity ω in a uniform magnetic filed $\vec{B} = B_0\hat{z}$. Calculate the emf developed between the north pole and equator?

3. A long solenoid with radius a and turns n per unit length carries a time dependent current $I(t)$ in the $\hat{\phi}$ direction. Find the electric field at a distance s from the axis(both inside and outside the solenoid), in the quasistatic approximation.