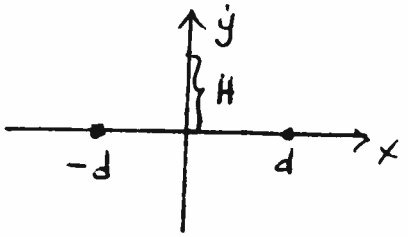
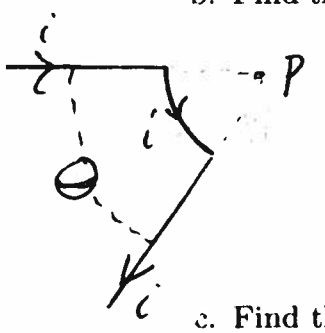
1. (25 points)

a. Two infinitely long, extremely thin wires, each carry a current i directed into the page $(-\vec{i}_z,)$ If one of the wires is on the x axis at $x = d$, and the second is on the x axis at $x = -d$, find the x,y, and z components of the total magnetic field at the point with $x = 0$, $z = 0$ and $y = H$.



A very thin current carrying wire has the shape shown below. The straight segments can be assumed to extend to infinity.

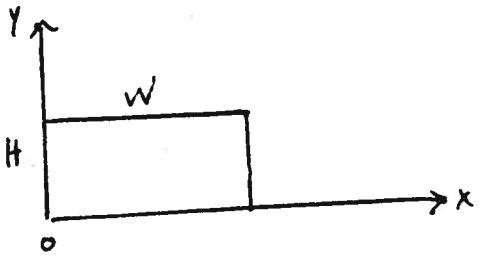
b. Find the magnetic field at the point marked P due to the two straight segments.



c. Find the magnetic field at the point marked P which is at the center of the circular segment that has radius W.

2. (25 points)A rectangular loop is made of wire which has resistivity ρ and cross sectional area a. The dimensions of the loop are H and W as shown. A magnetic field points into the page with magnitude $B = B_0(\alpha + \beta x)$ where α and β are known, positive constants.

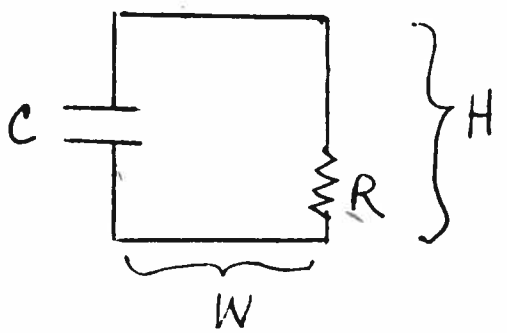
a. Find the flux of $\vec{B}$ through the loop when it is in the position shown.



b. Find the resistance of the loop.

c. Find the current, magnitude and direction, in the loop if the loop moves to the right at a velocity of constant magnitude v_0 and self inductance is ignored.

3. (25 points) In the circuit below all self inductance is assumed to be contained in the coil which has inductance L. A magnetic field is turned on at time $t = 0$ which points out of the page with a magnitude that increases with time according to $B = B_0\gamma t$ where γ is a constant. The capacitor is originally uncharged.

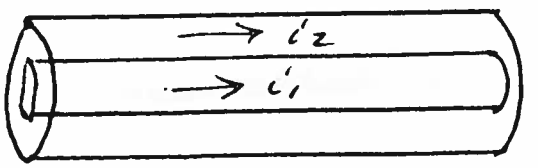


a. Derive the equation, starting with a law, that could be solved for the charge on the top plate of the capacitor. No credit will be given if the direction of the current and the charges on the capacitor plates are not indicated on the figure.

b. Solve for the charge on the top plate of the capacitor assuming the self inductance can be neglected.

4. (25 points)A wire is made of a cylinder of radius a and resistivity ρ_1 inside a hollow cylinder of inner radius a and outer radius b and resistivity ρ_2. Both cylinders have length W. It is attached to a battery of voltage V by the usual perfectly conducting wires.

a. If the inner cylinder has a current i_1 uniformly spread over its cross section, find the magnetic field at all points in the inner cylinder.



b. If the outer cylinder has a current i_2 uniformly spread over its cross section, find the magnetic field at all points in the outer cylinder.

c. Find i_1 and i_2.