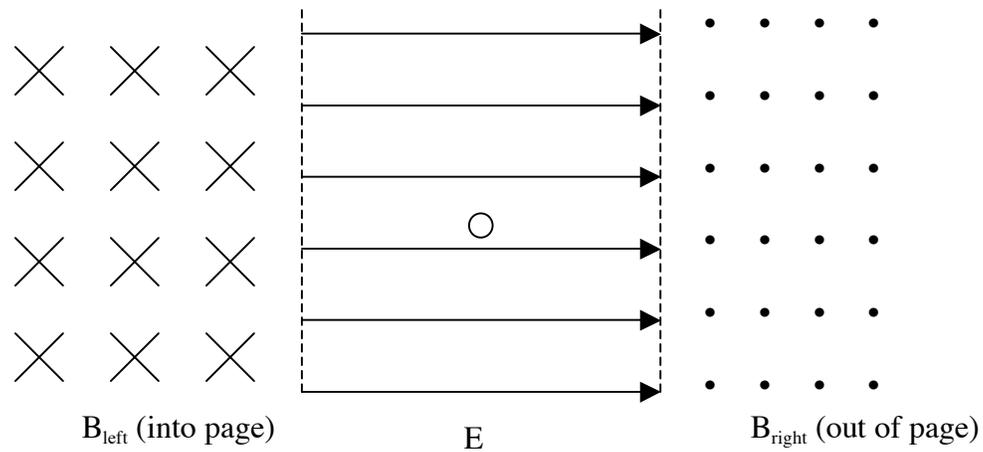1. (20 pts) The paper is divided into three regions with uniform magnetic and electric fields B_{left}, E, B_{right} as shown. The electric field region has width D. An electron is released from rest at the midpoint of the electric field region.

B_{left} (into page)   E B_{right} (out of page)
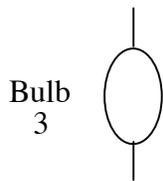
(Think about this problem. What will happen? Why? If you understand that, you will be able to answer questions posed at review)

2. (20 pts) In the circuit shown below, the two bulbs can be considered ideal resistors. The battery is ideal.
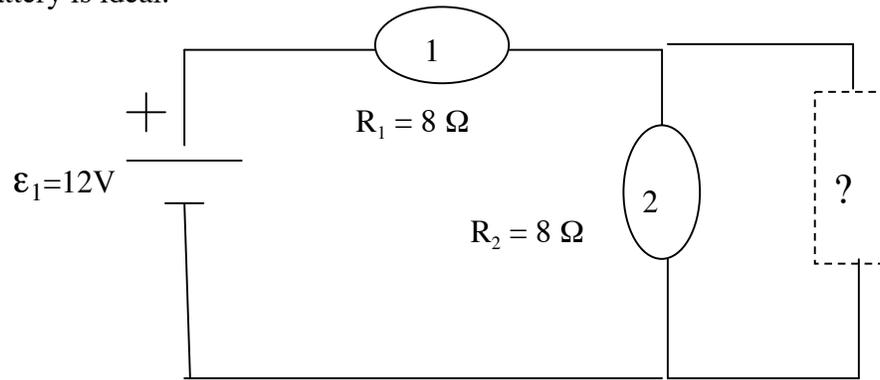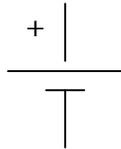

The mystery box can be one of five cases. Assume that in each case, the circuit has been operating a long time and has achieved steady-state.
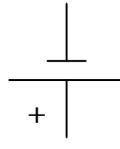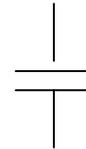

| Bulb 3	$\varepsilon_2 = 5$ V	$\varepsilon_3 = 5$ V	$C = 2$ F	$L = 3$ H
$R_3 = 8\ \Omega$				
(I)	(II)	(III)	(IV)	(V)

(Think about this problem. What will happen? Why? If you understand that, you will be able to answer questions posed at review)

3. (20 pts) A rectangular metal loop (width = L and height = H) is sitting in a magnetic field, B, directed into the page. The loop has two light bulbs (resistance, R) in it as shown. A metal bar rests on top of the loop and starts at the left edge of the loop. You slide the bar along the loop to the right at constant velocity, v. The figure shows the bar's position at some later time.
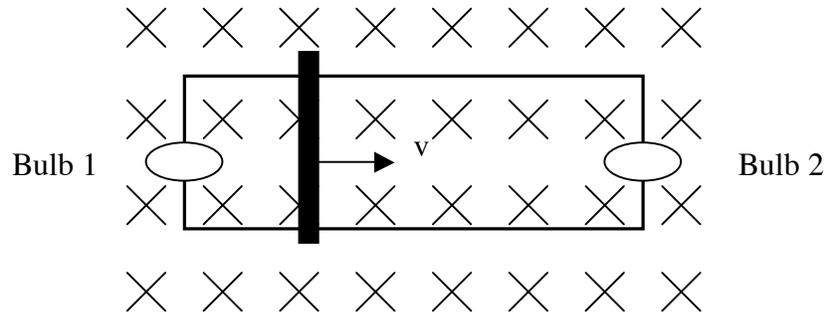
a) Find the direction of the current (if any) in each bulb. Specify up, down or zero. Explain.
b) Which bulb (if either) is brighter? Explain.
c) Find the total work done by you sliding the bar from the left edge to the right edge.

4. (20 pts) A very long copper rod (radius $R_1 = R$ and length L) is surrounded by an equally long thick-walled aluminum cylinder (inner radius $R_2 = 2R$, outer radius $R_3 = 3R$). At r = 1.5R the electric field has magnitude $E_{1.5}$ and points toward the copper rod. At the same location, the potential is $V = +V_{1.5}$ (measured relative to some reference point V = 0V). The system
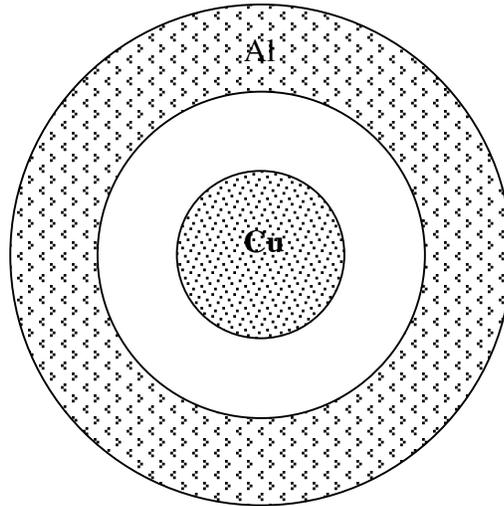
a) Show the arrangement of + and – charges and draw the electric field lines everywhere for 3 cases. (Be sure the pictures are qualitatively accurate)

- $|Q_{cu}| = |Q_{Al}|$
- $Q_{Al} = 0$
- $Q_{Al} > 0$ and $Q_{Al} = 3 * |Q_{Cu}|$

b) For the third case, at what radius (or radii) is the potential, V, greatest? Explain.

c) For the third case, Find (in terms of variables given in the problem)

- Q_{Cu} and Q_{Al}
- The electric field at r = 4R
- The magnetic field at r = 4R

5. We will also do some lightening round questions and I will take requests from those in attendence.