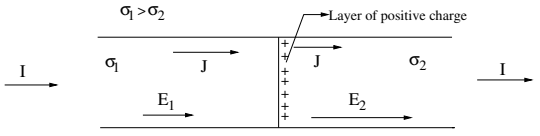
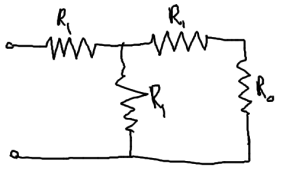
# PHY102 : Assignment 5

1. (Purcell 4.5) Show that the total amount of charge at the junction of two materials as shown, is $I\epsilon_0(1/\sigma_1 - 1/\sigma_2)$, where $I$ is the current flowing through the junction, in amperes, and the conductivities $\sigma_1$ and $\sigma_2$ are expressed in SI units.

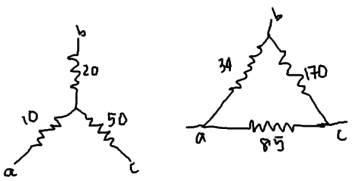



2. (Purcell 4.8) A copper wire 1 km long is connected across a 6-volt battery. The resistivity of the copper is $1.7 \times 10^{-8}$ohm-m. ; the number of conduction electrons per cubic meter is $8 \times 10^{28}$. What is the drift velocity of the conduction electrons under these circumstances ? How long does it take an electron to drift once around the circuit ?

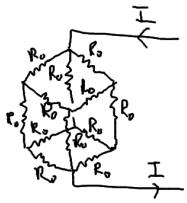
3. (Purcell 4.16) In the circuit, if $R_0$ is given, what value must $R_1$ have in order that the input resistance between the terminals should be equal to $R_0$ ?



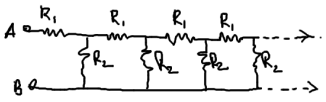

4. (Purcell 4.20) A black box with three terminals, $a, b, c$ contains nothing but three resistors and connecting wire. Measuring the resistance between pairs of terminals, we find $R_{ab} = 30$ ohms, $R_{ac} = 60$ ohms and $R_{bc} = 70$ ohms. Show that the contents of the box could be either configuration as shown in figure. Is there any other possibility ? Are the two boxes completely equivalent, or is there an external measurement that would distinguish between them ?



5. (Purcell 4.31) Suppose a cube has a resistor of resistance $R_0$ along each edge. At each corner the leads from three resistors are soldered together. Find the equivalent resistance between two nodes that represent diagonally opposite corners of the cube. Now find the equivalent resistance between two nodes that correspond to diagonally opposite corners of one face of the cube.



6. (Purcell 4.32) Find the "input resistance", that is, the equivalent resistance between terminals A and B of the following infinite series. Show that, if voltage



$V_0$ is applied at the input to such a chain, the voltage at successive nodes decreases in a geometric series. What ratio is required for the resistors to make the ladder an attenuator that halves the voltage at every step ? Obviously a truly infinite ladder would not be practical. Can you suggest a way to terminate it after a few sections without introducing any error in its attenuation ?