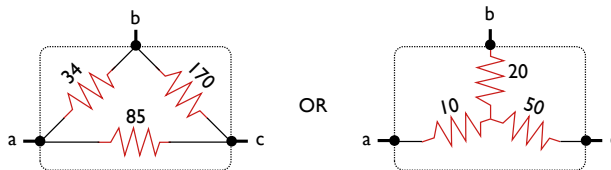


Problem Set 5: Current and Resistance

Instructions:

1. Answer all questions below. Show your work for full credit.
2. Due at the end of **Wed.** 1 Oct. 2008
3. You may collaborate, but everyone must turn in their own work

1. Two resistors R_1 and R_2 are in parallel with each other. Together they carry total current I . **(a)** Determine the current in each resistor. **(b)** Prove that this division of the total current I between the two resistors results in less power delivered to the combination than any other. It is a general principle that current in a dc circuit distributes itself so that the total power delivered is a minimum.
2. Show that if a battery of fixed internal voltage ΔV and internal resistance R_i is connected to a variable external resistance R the maximum power is delivered to the external resistor when $R_i = R$.
3. A black box with three terminals, a , b , and c , contains nothing but three resistors and connecting wire. Measuring the resistance between pairs of terminals, you measure $R_{ab} = 30\ \Omega$, $R_{ac} = 60\ \Omega$, and $R_{bc} = 70\ \Omega$. Show that the box could be either of those below.



4. A copper wire 1 km long is connected across a 6 V battery. The resistivity of the copper is $1.7 \times 10^{-8}\ \Omega\text{m}$, and the number of conduction electrons per cubic meter is 8×10^{28} . **(a)** What is the drift velocity of the conduction electrons under these circumstances? **(b)** How long does it take an electron to drift once around the circuit?
5. Each of the twelve edges of the cube is a resistor R . What is the resistance between two *opposite corners*?
6. A laminated conductor was made by depositing, alternately, layers of silver 10 nm thick and layers of tin 20 nm thick. The composite material, considered on a larger scale, may be considered a homogeneous but anisotropic material with electrical conductivity σ_{\perp} for currents perpendicular to the planes of the layers, and a different conductivity σ_{\parallel} for currents parallel to that plane. Given that the conductivity of silver is 7.2 times that of tin, find the ratio $\sigma_{\perp}/\sigma_{\parallel}$.