

Physics 1320: Homework #9

Due Friday, 4/1/2022

Please read Chapter 26 in your textbook. Also consult posted lecture notes on "Resistors in Series and Parallel". Reminder: Exam 2 will be on Monday, March 28.

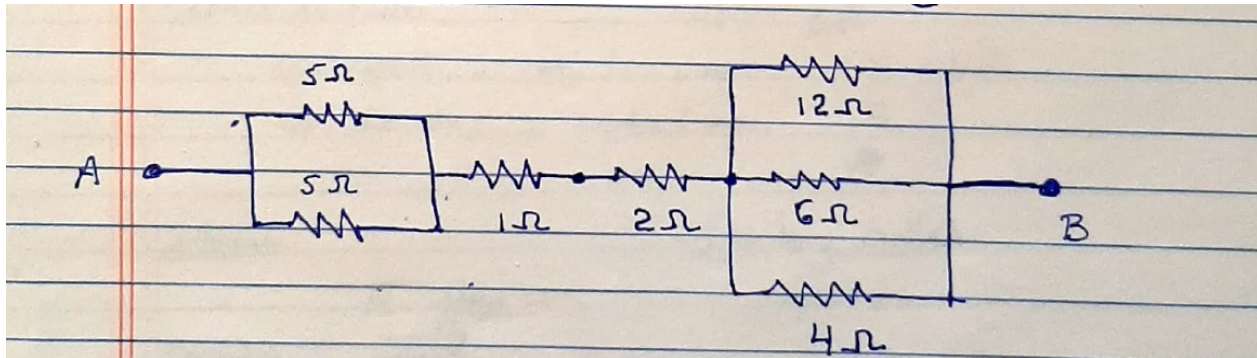
1. What is the conductance of device consisting of two concentric metal shells, the inner one having a radius of 20 cm, and the outer one having a radius of 40 cm, when the volume between the two shells is filled with tap water having a conductivity of $200 \mu\text{S/m}$? (a) For a 1 volt difference between the two shells, what is the electrical current? (b) What is the current density \vec{J} at a radius slightly greater than 20 cm? What is the current density at a radius just shy of 40 cm?

2. A capacitor having a capacitance of $2.0 \mu\text{F}$ consists of two metal electrodes separated by an insulating spacer made of crystalline silicon. Silicon is a semiconductor, having a conductivity of $1.6 \times 10^{-3} \text{ S/m}$ and dielectric constant of 11.7. The capacitor is placed in a series with a 12 volt battery in a closed loop circuit. When steady state is reached, what is the charge on the capacitor, and what is the current in the circuit?

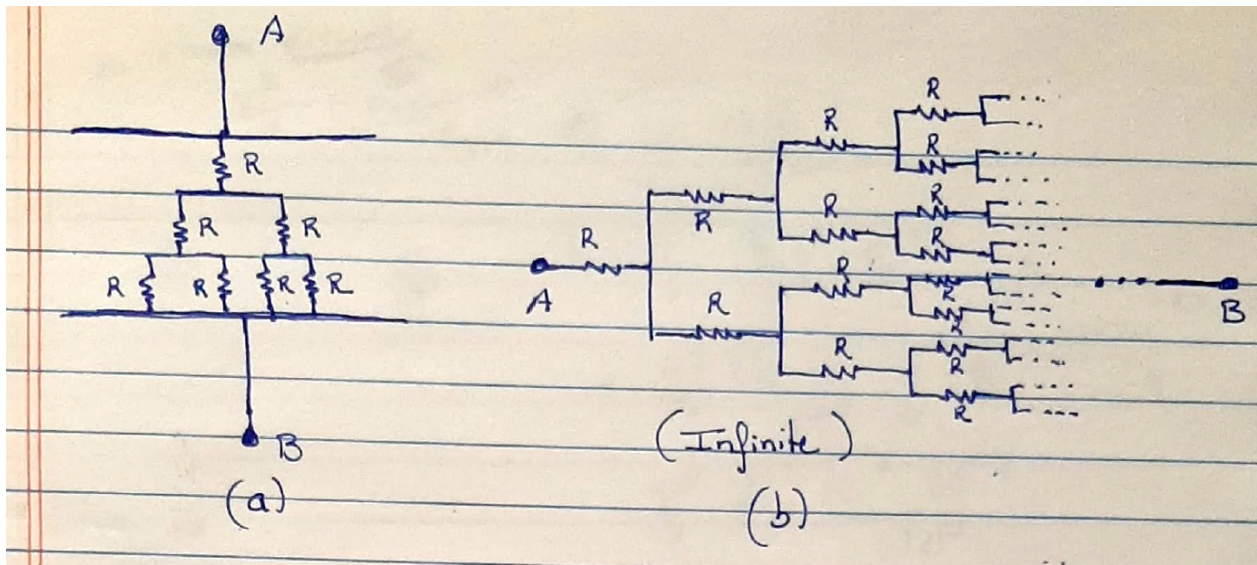
3. Look up tabulated conductivities (or resistivities) of copper, silver, and aluminum at 20°C and calculate the resistance of a copper wire that is 2 meters long with a 1 mm diameter. Repeat your calculation for silver, and for aluminum. The density of free electrons is $8.5 \times 10^{28} \text{ particles/m}^3$ for copper, $5.86 \times 10^{28} \text{ m}^{-3}$ for silver, and $18.1 \times 10^{28} \text{ m}^{-3}$ for aluminum. For a potential difference of 5 volts, how do the electron drift velocities in each of the three wires compare with one another?

4. The heating element in an oven has a resistance of $R = 32 \Omega$. One of the wires connecting the oven to the 220 volt power source is loose, contributing an additional $r = 5 \Omega$ to the closed-loop circuit. What is the power P_{oven} radiated in the oven, and what is the rate P_{contact} at which heat is dissipated at the loose contact? The looser is the connection, the greater is the resistance r . What value of r is most likely to cause a fire? Use the computer to make a graph showing P_{contact} versus r . You may wish to consult the video from the Master Samarai Tech: <https://mastersamuraitech.com/loose-electrical-connections-and-heat/>

5. Consider the resistor network connecting points A and B in the figure below. What is the equivalent resistance between points A and B? If the potential difference between A and B is 12 volts, what is the current in the 4Ω resistor? What is the rate at which heat is produced in the 4Ω resistor?



6. Consider the branching resistor network connecting points A and B in figure (a) below. Each resistor has a resistance R . What is the equivalent resistance between points A and B? What would be the equivalent resistance between A and B if the branched network extends indefinitely, as shown in figure (b) below?



7. Consider the network of 8 resistors shown in the figure below. Each has a resistance R . What is the equivalent resistance between A and C? What is the equivalent resistance between A and B?

