PHYS 51W - Workshop - Week 6 - March 9 – 15

The problems are based on Chapter 25: Current, Resistance, and Electromotive Force.

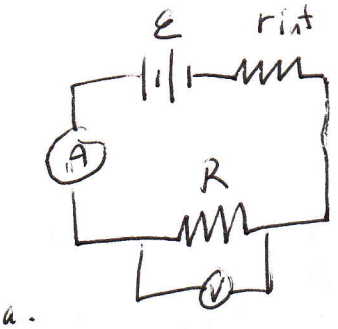
1. In a 100 watt light bulb, the dc current is approximately 1 amp.
   a. If you leave the bulb on for 24 hours, how much charge flows through it?
   b. How many electrons per day move through the light bulb?
   c. Suppose the thickness of the filament of this light bulb has a diameter of 0.01 inch. What is the current density J? (Hint: the units are Amp/m^2.)

2. A wire carries electricity from Hetch Hetchi Dam to San Jose. The length of the wire is 150 miles; the cross sectional area is 20 cm^2. If the wire is made of copper, what is its electrical resistance.
   (For copper, the resistivity $\rho = 1.72 \times 10^{-8}$ Ω.m)

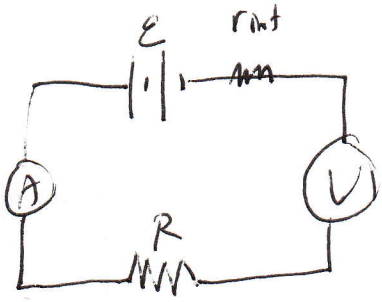
3. A carbon resistor has a resistance of 100 Ω at 20 °C. On a hot Summer's day, the temperature rises to 37 °C. What is the new resistance? (The resistivity of carbon is 3.5 x 10-5 W.m at 20 °C; the temperature coefficient of resistivity of carbon is $\alpha = -0.0005\ (^{\circ}C)^{-1}$.

4. When a certain battery draws no current, the voltage across its terminals is 6.0 V. When the battery draws a current of 1.5 A, the voltage falls to 5.5 V.
   a. What is the internal resistance of the battery?
   b. If you short-circuited the battery, how much current would the battery produce?

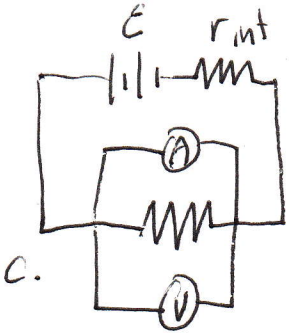
5. Below you find a circuit with an emf ε = 5.0 volts and an internal resistance of 0.50 Ω. It is connected to a 2.0 Ω resistor. Ideal ammeters and voltmeters are connected as shown. In each case, indicate the reading of the ammeter and voltmeter.



a.



b.



c.

6. The resistivity of copper is $\rho = 1.72 \times 10^{-8}\ \Omega.m$, and the resistivity of silver is $\rho = 1.47 \times 10^{-8}\ \Omega.m$.

a. A copper wire has a length of 15.0 m and a diameter of 1.0 mm. It carries a current of 1.20 A. Find the resistance, the current density J, and the Electric field inside the copper wire.

b. Answer these question again if the wire is made of silver?

7. A battery has an emf $\varepsilon = 10.0$ V and an internal resistance of 0.50 Ω. It is connected to a 4.50 Ω resistor.

a. What current goes through the resistor?

b. What power is delivered to the resistor?

c. What power is dissipated inside the battery?

8. A battery has an emf ε and an internal resistance r. It is connected to a resistor R.

a. What current goes through the resistor?

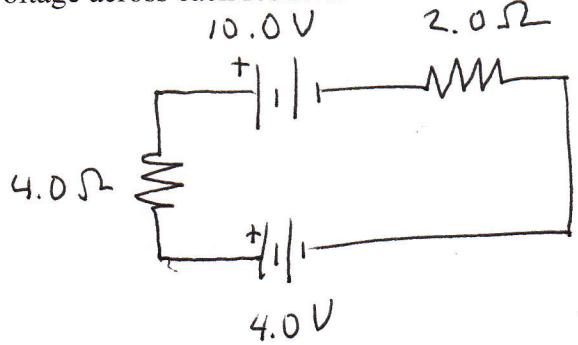
b. What power is delivered to the resistor?

c. For what value of R is the power delivered to the resistor a maximum?

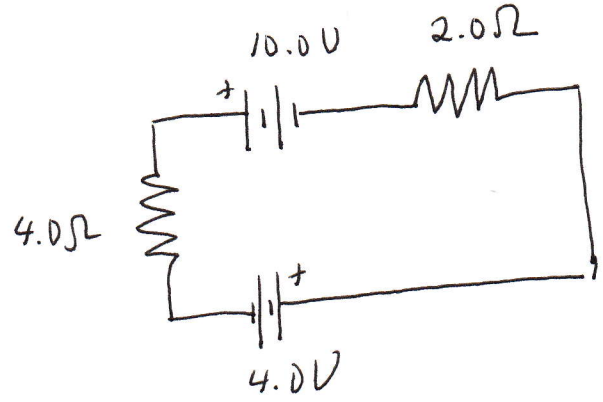
9. a. In the circuit diagram below, the batteries have no internal resistance. Find the current in each resistor and the voltage across each resistor.

b. In circuit b, one of the batteries has been reversed. Find the current in each resistor and the voltage across each resistor.

a.



b.



10. A wire is 1.0 m long. It has a cross sectional area of 5.0×10^{-7} m^2. Its resistance is 1.30 Ω.

a. What is the resistivity?

b. If you connected 100 such wires in a row, what would be the new resistance? The new resistivity?

c. If you bundled 100 such wires side by side, what would be the new resistance? The new resistivity?

11. The resistivity of the human body is roughly $\rho = 5.0\ \Omega.m$. A person's hands are about 1.0 m apart. When they grab a wire, the area through which current can flow is roughly cylindrical, with a diameter of 0.10 m.

a. What is the resistance between the person's hands?

b. A lethal current would be 100 mA. What voltage would cause this current?

c. What power does the potential deliver while causing this current?