(a) In iron at room temperature, the mobility of mobile electrons is about 7.5 × 10^{-3} (m/s)/(V/m), and there are about 8.4 × 10^{28} mobile electrons per m^3. Calculate the conductivity σ. In actual practice, it is usually easier to measure the conductivity σ and deduce the mobility u from this measurement.

(b) What are the correct units for σ?

- ○ (A•m)/V
- ● (A/m^2)/(V/m)
- ○ (A/m)/(V/m^2)
- ○ (m/A)/(V/m^3)

$$\sigma = |q| n u$$

$$= 1.008e8 \ \frac{A}{m^2} / \frac{V}{m}$$

Consider a magnesium wire (σ = 2.2 × 10^7 $\Omega^{-1} \cdot m^{-1}$) with a cross-sectional area of 1 mm^2 (similar to your connecting wires) and carrying 0.3 amperes of current, which is about what you get in a circuit with a round bulb and two batteries in series. Calculate the strength of the very small electric field required to drive this current through the wire.

V/m

$$J = \frac{I}{A}$$

$$E\sigma = \frac{I}{A}$$

$$\frac{1 \ mm}{0.001 \ m} \rightarrow \frac{1 \ mm^2}{(0.001 \ m)^2}$$

$$E = \frac{I}{A\sigma}$$

$$= 1.3636e{-2} \ V/m$$

A carbon resistor is 7 mm long and has a constant cross section of 0.4 mm^2. The conductivity of carbon at room temperature is σ = 3 × 10^4 per ohm·m. In a circuit its potential at one end of the resistor is 15 volts relative to ground, and at the other end the potential is 19 volts. Calculate the resistance R and the current I.

R = Ω

I = amperes

$$R = \frac{L}{\sigma A}$$

$$= 0.583 \ \Omega$$

$$V = IR$$

$$I = \frac{V}{R}$$

$$= \frac{V_+ - V_-}{R}$$

$$= 6.857 \text{ A}$$

(a) The current through a particular high-resistance (long) bulb when connected to two batteries in series (3.1 volts) is about 110 milliampere (mA); connected to one battery (1.55 volts) the current is about 70 mA; and connected to a small voltage of only 50 millivolts the current is about 6 mA. (Different high-resistance (long) bulbs may differ from these values somewhat.) Using the formula $I = |\Delta V|/R$, what is R for each of these cases?

$R_{3.1\text{ V}}$ = ____ Ω

$R_{1.55\text{ V}}$ = ____ Ω

$R_{50\text{ mV}}$ = ____ Ω

(b) Is a high-resistance (long) bulb an ohmic resistor over this whole range of currents?

- ○ The bulb is ohmic, because it is not possible for the resistance of any resistor to change.
- ◉ The bulb is not ohmic, because its resistance changes if the current through the bulb changes.
- ○ The bulb is ohmic because one can use the formula $R = |\Delta V|/I$.
- ○ The bulb is ohmic, because light bulbs are ohmic.

$$V = IR$$

$$R = \frac{V}{I}$$

$$R_{3.1} = 28.182\ \Omega$$

$$R_{1.55} = 22.143\ \Omega$$

$$R_{0.05} = 8.333\ \Omega$$

A certain ohmic resistor has a resistance of 40 ohms. A second resistor is made of the same material but is three times as long and has half the cross-sectional area. What is the resistance of the second resistor?

____ Ω

What is the effective resistance of the two resistors in series?

____ Ω

$$R = \frac{L}{\sigma A}$$

$$R_{new} = \frac{3L}{\sigma \frac{1}{2} A}$$

$$R_{new} = 6 \frac{L}{\sigma A}$$

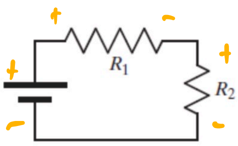
$$R_{new} = 6 R_{old}$$

$$R_{new} = 240\ \Omega$$

$$R_{series} = 240 + 40$$

$$= 280\ \Omega$$

In the circuit shown in the figure below, the emf of the battery is 9.1 V. Resistor R_1 has a resistance of 19 Ω, and resistor R_2 has a resistance of 39 Ω. A steady current flows through the circuit.



(a) What is the absolute value of the potential difference across R_1?

V

(b) What is the conventional current through R_2?

A

Part One

KVL on the only loop

$$9.1 - 19I - 39I = 0$$

$$58I = 9.1$$

$$I = 0.157\ \text{A}$$

$$V_{R1} = IR_1$$

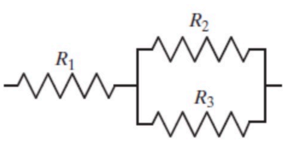
$$= 2.981 \, v$$

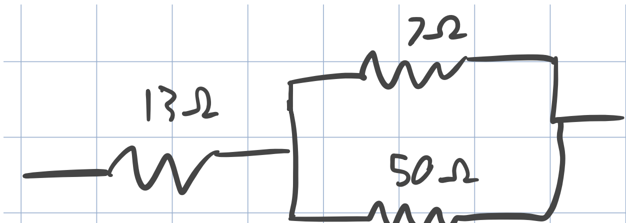
Part Two

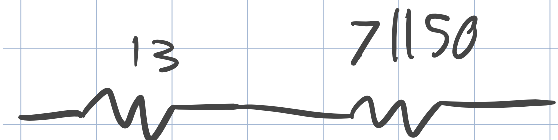
$I = 0.157$ A as found earilier

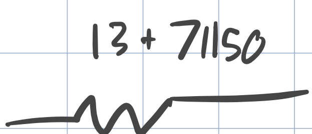
In the figure below the resistance R_1 is 13 Ω, R_2 is 7 Ω, and R_3 is 50 Ω. If this combination of resistors were to be replaced by a single resistor with an equivalent resistance, what should that resistance be?

[ ] Ω





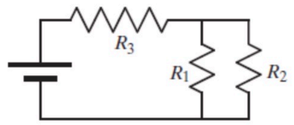




$$R_{eff} = 13 + \frac{7 \cdot 50}{7 + 50}$$

$$= 19.140 \, \Omega$$

In the circuit shown in the figure below the emf of the battery is 7.2 V. Resistor R_1 has a resistance of 25 Ω, resistor R_2 has a resistance of 48 Ω, and resistor R_3 has a resistance of 58 Ω. A steady current flows through the circuit.



(a) What is the equivalent resistance of R_1 and R_2?

Ω

(b) What is the equivalent resistance of all three resistors?

Ω

(c) What is the conventional current through R_3?

A

$$R_{1 \text{ and } 2} = \frac{R_1 R_2}{R_1 + R_2}$$

$$= 16.438\ \Omega$$

$$R_{eq} = R_{1 \text{ and } 2} + R_3$$

$$= 74.438\ \Omega$$

$$V = IR$$

$$I = \frac{V}{R}$$

$$= 96.7\ \text{mA}$$