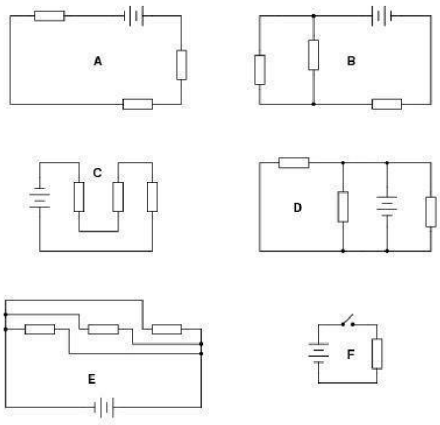
CS362 :: Homework 1

Ryan Magdaleno

February 2, 2024

Problem 1. Consider the following circuits. The resistors are shown as empty rectangles in the diagrams below.



Solution ::

a) Identify which of these circuits contains resistors only in series.

$$A, C, F$$

b) Identify which of these circuits contains resistors only in parallel.

$$D, E$$

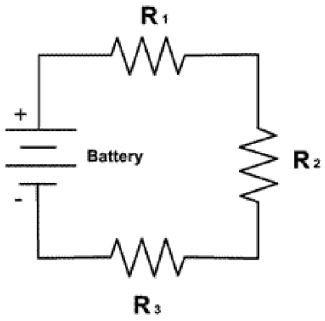
c) Identify which of these circuit contain resistors in a combination of both series and parallel.

$$B$$

Problem 2. Calculate appropriate values for each of the following series circuits. Show your work.

Solution ::

a) ::



Assume that for the circuit:

The battery is 12V
R1 is 1kΩ
R2 is 2kΩ
R3 is 4kΩ

Determine the total Resistance for the circuit.

$$\begin{aligned} R_T &= R_1 + R_2 + R_3 \\ R_T &= 1\text{k}\,\Omega + 2\text{k}\,\Omega + 4\text{k}\,\Omega \\ R_T &= 7\text{k}\,\Omega \end{aligned}$$

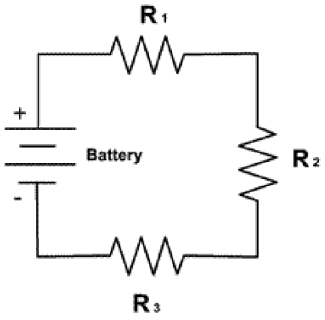
Determine the Current for the entire circuit.

$$\begin{aligned} I &= \frac{V}{R_T} \\ I &= \frac{12}{7000} \end{aligned}$$

Determine the Voltage Drop across each of the 3 resistors.

$$\begin{aligned} V_1 = IR_1 &= \frac{12}{7000} \cdot 1000 \approx 1.71429V \\ V_2 = IR_2 &= \frac{12}{7000} \cdot 2000 \approx 3.42857V \\ V_3 = IR_2 &= \frac{12}{7000} \cdot 4000 \approx 6.85714V \\ 12V &= V_1 + V_2 + V_3 \end{aligned}$$

b) ::



Assume that for the circuit:

The battery is 5V
R1 is 10Ω
R2 is 20Ω
R3 is 30Ω

Determine the total Resistance for the circuit.

$$\begin{aligned} R_T &= R_1 + R_2 + R_3 \\ R_T &= 10\,\Omega + 20\,\Omega + 30\,\Omega \\ R_T &= 60\,\Omega \end{aligned}$$

Determine the Current for the entire circuit.

$$\begin{aligned} I &= \frac{V}{R_T} \\ I &= \frac{5}{60} \\ I &= 0.08\overline{3}A \end{aligned}$$

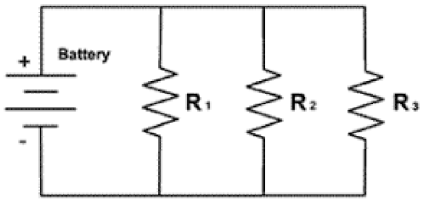
Determine the Voltage Drop across each of the 3 resistors.

$$\begin{aligned} V_1 = IR_1 &= 0.08\overline{3} \cdot 10 = 0.8\overline{3}V \\ V_2 = IR_2 &= 0.08\overline{3} \cdot 20 = 1.\overline{6}V \\ V_3 = IR_2 &= 0.08\overline{3} \cdot 30 = 2.5V \\ 5V &= V_1 + V_2 + V_3 \end{aligned}$$

Problem 3. Calculate appropriate values for each of the following parallel circuits. Show your work.

Solution ::

a) ::



Assume that for the circuit:

The battery is 12V
R1 is 10Ω
R2 is 20Ω
R3 is 40Ω

Determine the total Resistance for the circuit.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$
$$\frac{1}{R_T} = \frac{1}{10} + \frac{1}{20} + \frac{1}{40}$$
$$\frac{1}{R_T} = 0.175\,\Omega$$
$$R_T = \frac{40}{7} \approx 5.71429\,\Omega$$

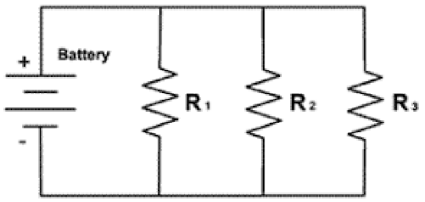
Determine the Current for the entire circuit.

$$I_{in} = \frac{V}{R_T}$$
$$I_{in} = \frac{12}{\frac{40}{7}}$$
$$I_{in} = 2.1A$$

Determine the Current passing through each of the 3 resistors.

$$I_i = \left(\frac{R_T}{R_i}\right) \cdot I_{in}$$
$$I_1 = \left(\frac{\approx 5.71429}{10}\right) \cdot 2.1 = 1.2A$$
$$I_2 = \left(\frac{\approx 5.71429}{20}\right) \cdot 2.1 = 0.6A$$
$$I_3 = \left(\frac{\approx 5.71429}{40}\right) \cdot 2.1 = 0.3A$$

b) ::



Assume that for the circuit:

The battery is 5V
R1 is 5Ω
R2 is 2Ω
R3 is 3Ω

Determine the total Resistance for the circuit.

$$\begin{aligned}
\frac{1}{R_T} &= \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \\
\frac{1}{R_T} &= \frac{1}{5} + \frac{1}{2} + \frac{1}{3} \\
\frac{1}{R_T} &= 1.0\overline{3}\,\Omega \\
R_T &= \frac{30}{31} \approx 0.96774\,\Omega
\end{aligned}$$

Determine the Current for the entire circuit.

$$\begin{aligned}
I_{in} &= \frac{V}{R_T} \\
I_{in} &= \frac{5}{\frac{30}{31}} = \frac{31}{6} \\
I_{in} &= 5.1\overline{6}A
\end{aligned}$$

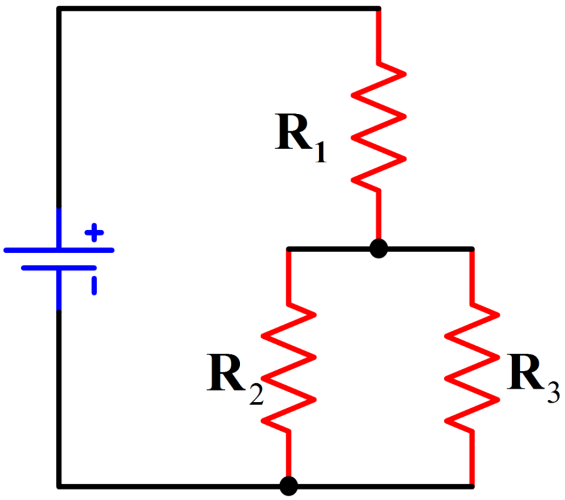
Determine the Current passing through each of the 3 resistors.

$$\begin{aligned}
I_i &= \left(\frac{R_T}{R_i}\right) \cdot I_{in} \\
I_1 &= \left(\frac{\approx 0.96774}{5}\right) \cdot 5.1\overline{6} = 1A \\
I_2 &= \left(\frac{\approx 0.96774}{2}\right) \cdot 5.1\overline{6} = 2.5A \\
I_3 &= \left(\frac{\approx 0.96774}{3}\right) \cdot 5.1\overline{6} = 1.\overline{6}A
\end{aligned}$$

Problem 4. Calculate appropriate values for each of the following circuits. Show your work.

Solution ::

a) ::



Assume for the circuit:

The battery is 12v
R1 is 2kΩ
R2 is 4kΩ
R3 is 8kΩ

Determine the total Resistance for the circuit.

$$R_T = 2000 + \frac{1}{\frac{1}{4000} + \frac{1}{8000}}$$

$$R_T = \frac{14000}{3} = 4666.\overline{6}\,\Omega$$

Determine the Current for the entire circuit.

$$I_{in} = \frac{12}{4666.\overline{6}}$$

$$I_{in} = \frac{9}{3500} \approx 0.00257A$$

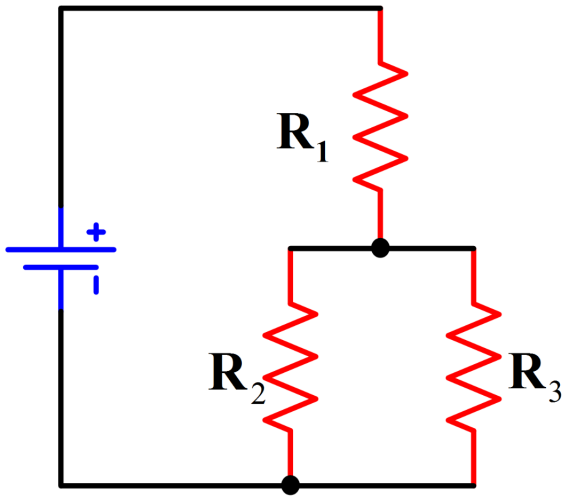
Determine the Current passing through each of the 3 resistors.

$$I_1 = I_{in} \approx 0.00257A$$

$$I_2 = 0.00257 \cdot \left(\frac{2666.6}{4000}\right) \approx 0.00171A$$

$$I_3 = 0.00257 \cdot \left(\frac{2666.6}{8000}\right) \approx 0.00086A$$

b) ::



Assume for the circuit:

The battery is 5v
R1 is 10Ω
R2 is 20Ω
R3 is 40Ω

Determine the total Resistance for the circuit.

$$R_T = 10 + \frac{1}{\frac{1}{20} + \frac{1}{40}}$$
$$R_T = \frac{70}{3} = 23.\overline{3}\,\Omega$$

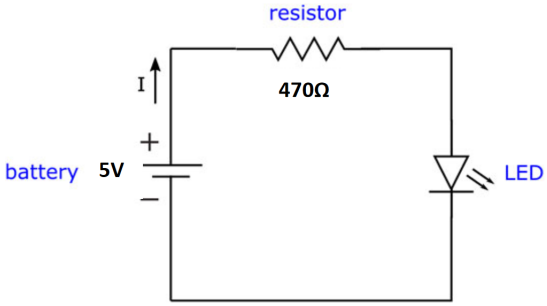
Determine the Current for the entire circuit.

$$I_{in} = \frac{5}{23.\overline{3}}$$
$$I_{in} = \frac{3}{14} \approx 0.21429A$$

Determine the Current passing through each of the 3 resistors.

$$I_1 = I_{in} \approx 0.21429A$$
$$I_2 = \frac{3}{14} \cdot \left(\frac{13.\overline{3}}{20}\right) \approx 0.00143A$$
$$I_3 = \frac{3}{14} \cdot \left(\frac{13.\overline{3}}{40}\right) \approx 0.00071A$$

Problem 5a. You have a circuit with a 5 volt power source, a 470 ohm resistor, and an LED. Assume your 5V power supply stops working, but you have a 12V power supply. You want to keep the current at the LED the same. What resistor value would be needed if you changed your power source from 5 volts to 12 volts and, you want to keep the current at the LED the same? Assume that the LED adds no resistance to the current.



Solution ::

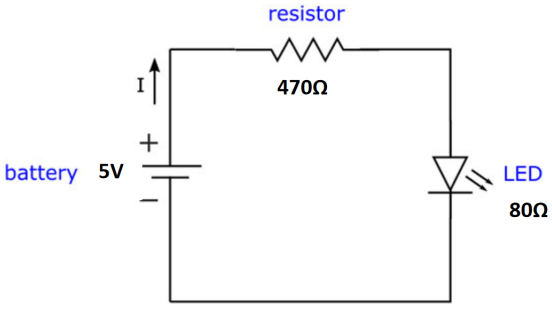
$$I_1 = \frac{5}{470} = \frac{1}{94} \approx 0.01064A \tag{1}$$

$$R_1 = \frac{V}{I_1} \tag{2}$$

$$R_1 = \frac{12}{\frac{1}{94}} \tag{3}$$

$$R_1 = 1128\,\Omega \tag{4}$$

Problem 5b. You have a circuit with a 5 volt power source, a 470 ohm resistor, and an LED. However, assume the LED adds a resistance value of 80 ohms to the circuit. As with the previous problem, your 5V power supply stops working, but you have a 12V power supply. You want to keep the current at the LED the same. What resistor value would be needed if you changed your power source from 5 volts to 12 volts and, you want to keep the current at the LED the same?



Solution ::

$$R_T = 470 + 80 = 550\,\Omega \tag{5}$$

$$I = \frac{V}{R_T} = \frac{5}{550} = 0.009\overline{09}A \tag{6}$$

12V change but same current. (7)

$$R_T = \frac{12}{0.009\overline{09}} = 1320\,\Omega \tag{8}$$

$$R_1 = R_T - R_{LED} \tag{9}$$

$$R_1 = 1320 - 80 \tag{10}$$

$$R_1 = 1240\,\Omega \tag{11}$$