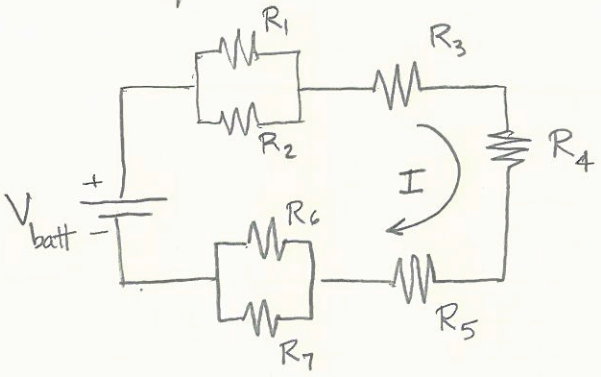
EAS 199A Example of DC Circuit Analysis



For the circuit represented by the schematic to the right, determine

a.) The current, I

b.) The power supplied by the battery

c.) The voltage across R_5

Use the following numerical values for the circuit parameters

$V_{batt} = 120\,V$

$R_1 = R_2 = 20\,\Omega$

$R_3 = 5\,\Omega$

$R_4 = 10\,\Omega$

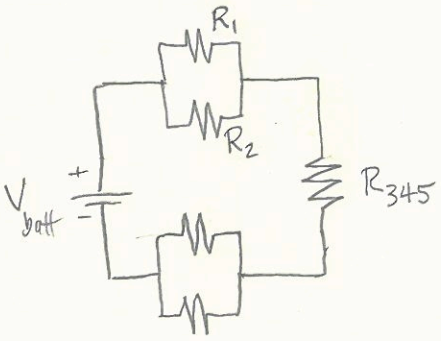
$R_5 = 15\,\Omega$

$R_6 = 25\,\Omega$

$R_7 = 100\,\Omega$

Note: The Given and Find steps in the standard format are not necessary because that information is provided in the problem statement. More interesting problems require the Given and Find steps to be part of the problem-definition phase of problem-solving

Solution: First combine the resistors in series

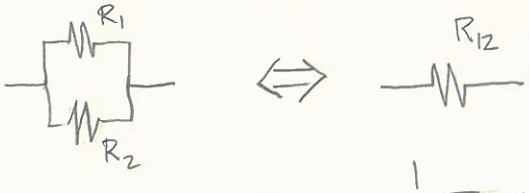


$$R_{345} = R_3 + R_4 + R_5$$

$$= 5\,\Omega + 10\,\Omega + 15\,\Omega$$

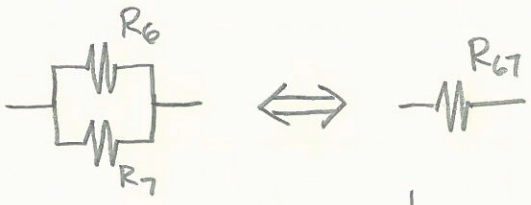
$$\boxed{R_{345} = 30\,\Omega}$$

Combine the resistors in parallel



$\therefore R_{12} = 10\,\Omega$

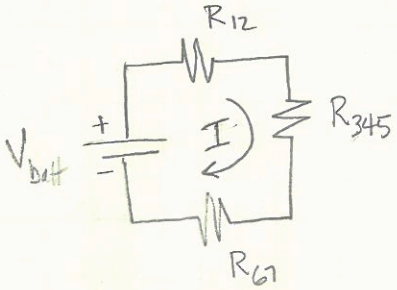
$$R_{12} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{1}{20\,\Omega} + \frac{1}{20\,\Omega}} = \frac{1}{\frac{2}{20\,\Omega}} = 10\,\Omega$$



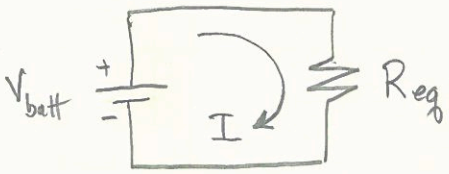
$$R_{67} = \frac{1}{\frac{1}{R_6} + \frac{1}{R_7}} = \frac{1}{\frac{1}{25\Omega} + \frac{1}{100\Omega}} = \frac{1}{\frac{5}{100\Omega}} = 20\Omega$$

$$\therefore R_{67} = 20\Omega$$

Replacing the parallel resistors with their equivalent values gives the following equivalent circuit



Combine the resistors in series:



$$R_{eq} = R_{12} + R_{345} + R_{67}$$

$$= 10\Omega + 30\Omega + 20\Omega$$

$$\therefore R_{eq} = 60\Omega$$

Apply Ohm's law to the simplified circuit and solve for I

$$V_{batt} = I R_{eq} \Rightarrow I = \frac{V_{batt}}{R_{eq}} = \frac{120\,V}{60\Omega} = 2\,A$$

$$\therefore \boxed{I = 2A}$$

b.) Compute the power supplied by the battery

Use the most simplified version of the circuit

$$P_{batt} = V_{batt} I = (120V)(2A) = 240W$$

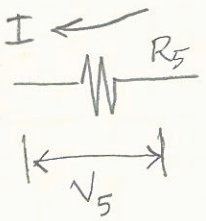
$$\boxed{P_{batt} = 240W}$$

c.) Voltage drop across R_5 is obtained by applying Ohm's Law

Refer to the original circuit diagram.

The current I flows through R_3, R_4 and R_5

Isolate R_5:



$$V_5 = I R_5 = (2A)(15\Omega)$$

$$= 30V$$

$$\boxed{V_5 = 30V}$$

Discussion

The results seem plausible

- R_{345} is greater than any of the resistors used in the series combination
- R_{12} is less than R_1 or R_2
- R_{67} is less than R_6 or R_7

The voltage across R_5 is less than the voltage across the battery.