Kirchoff's laws, Ohm's Law, and Circuit Analysis

Kirchoff's voltage law

- Electric potential difference is also referred to as voltage

- Kirchoff's Voltage Law:
  - In any complete path in an electric circuit, the total electric potential increase at the source(s) is equal to the total electric potential decrease throughout the rest of the cicuit

  - $V_{series} = V_1 + V_2 + V_3 + \ldots\ldots\ldots\ldots$

  - $V_{parallel} = V_1 = V_2 = V_3 = \ldots\ldots\ldots\ldots$

Kirchoff's Current Law

- In electric circuits, junctions are points where the current can split to follow more than one path

- Kirchoff's Current Law:
  - In a closed circuit, the amount of current entering a junction is equal to the amount of current exiting a junction.

  - $I_{series} = I_1 = I_2 = I_3 = \ldots\ldots\ldots\ldots$

  - $I_{parallel} = I_1 + I_2 + I_3 + \ldots\ldots\ldots\ldots$

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1. For the circuit in **Figure 7**, $V_{source} = 60.0\ V$, $V_1 = 20.0\ V$, and $V_3 = 15\ V$. Determine V_2, V_4, and V_5. T/I [ans: $V_2 = 25\ V$; $V_4 = 15\ V$; $V_5 = 15\ V$]

$V_2 = 25V$

$V_4 = V_5 = 15V$

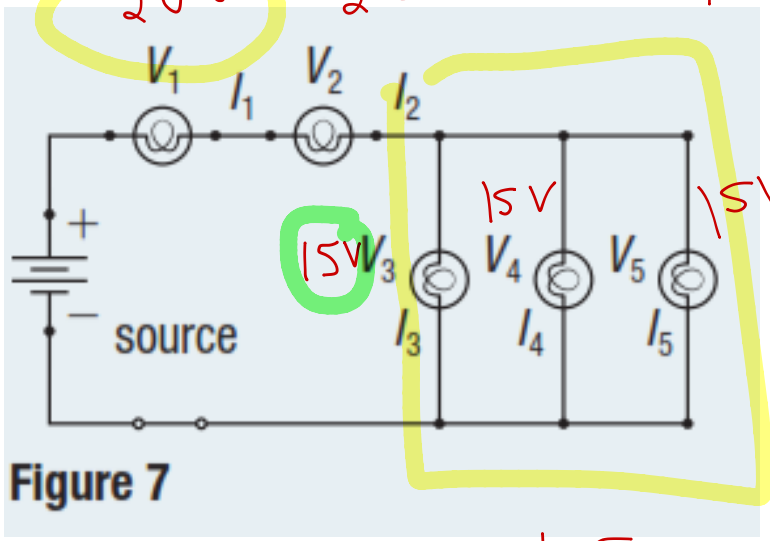

Figure 7

15V

$V_2 = 60\ V - 20V - 15V$

$V_2 = 25\ V$

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2. For the circuit in Figure 7, $I_1 = 0.70$ A, $I_3 = 0.10$ A, and $I_5 = 0.20$ A. Determine I_{source}, I_2, and I_4. T/I [ans: $I_{source} = 0.70$ A; $I_2 = 0.70$ A; $I_4 = 0.40$ A]

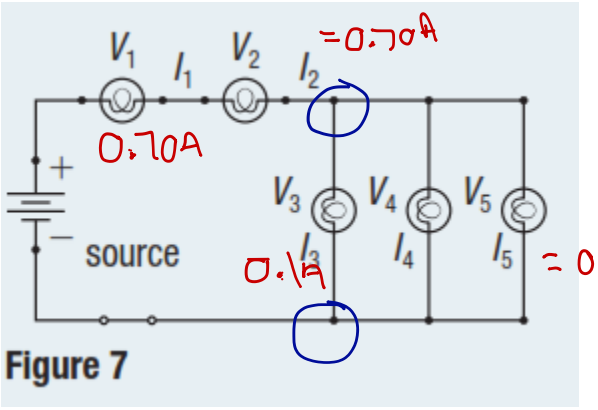


Figure 7

$I_{source} = 0.70A$

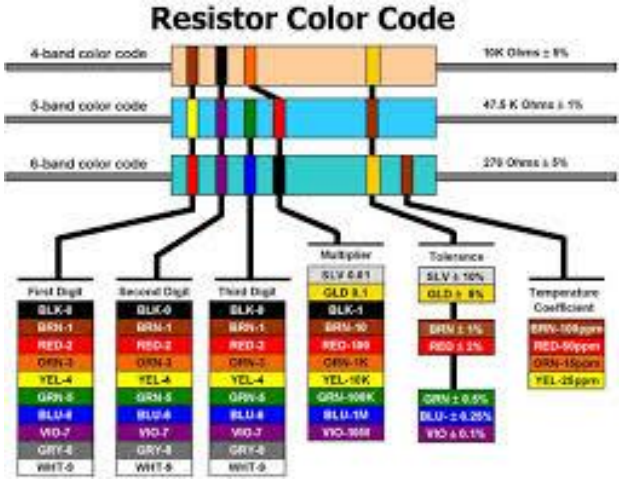
$I_4 = 0.7 - (0.1 + 0.2)$

$I_4 = 0.40A$

Electrical resistance

- Electrical resistance (R):
  - a property of matter that describes how difficult it is for electric current to travel through a material

- Resistor
  - an electrical device that has a specific resistance value



Ohm's law

- The voltage in a conductor is proportional to the current if the temperature remains constant.

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

$$V = I R$$

Ohm's Law

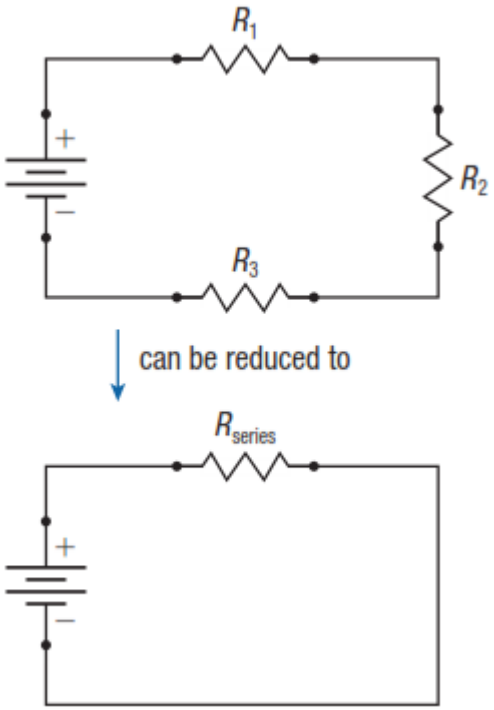
- R
  - resistance measured in volts per ampere (ohms)
- V
  - voltage measured in volts (V)
- I
  - electric current measured in amperes or amps (A)

Measuring resistance

- Ohmmeter
  - a device that measures electrical resistance
  - connected in parallel and ***must never*** be used on a live circuit

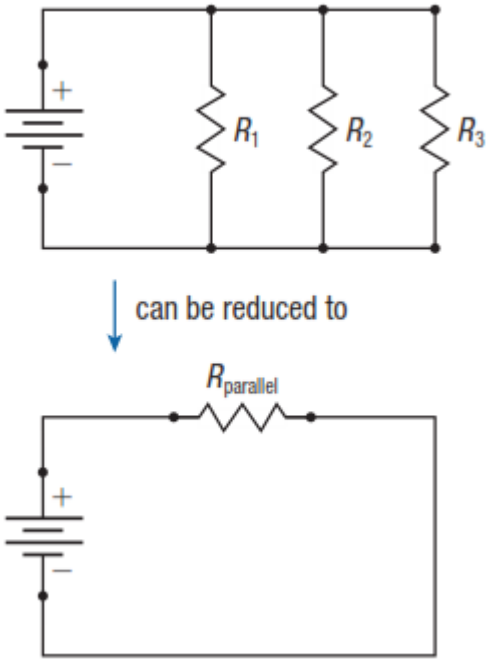
Resistors in circuits

- Resistors in Series
  - substitute Ohm's Law into KVL
  - generates an equivalent resistance
  - $R_{series} = R_1 + R_2 + R_3 + \ldots$



Resistors in circuits

- Resistors in parallel
  - Substitute Ohm's Law (isolate I) into KCL
  - generate an equivalent resistance
  - Equation: $\frac{1}{R_{parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$



Example #1

- Determine the equivalent resistance for a 25.2 ohm resistor connected in series with a 28.12 ohm resistor.

$$R_T = 25.2\,\Omega + 28.12\,\Omega$$

$$\begin{array}{r} {\scriptstyle 1} \\ 25.2 \\ +\ 28.12 \\ \hline 53.32 \end{array}$$

$$R_T = 53.3\,\Omega$$

Example #2

- Determine the equivalent resistance of a 120 ohm resistor connected in parallel with a 60 ohm resistor.

$$\frac{1}{R_{eq}} = \frac{1}{120\,\Omega} + \frac{1}{60\,\Omega}$$

$$= \frac{1}{120\,\Omega} + \frac{2}{120\,\Omega}$$

$$\frac{1}{R_{eq}} = \frac{3}{120\,\Omega}$$

$$R_{eq} = 120\,\Omega / 3 = 40\,\Omega$$

Equivalent resistance in mixed circuits

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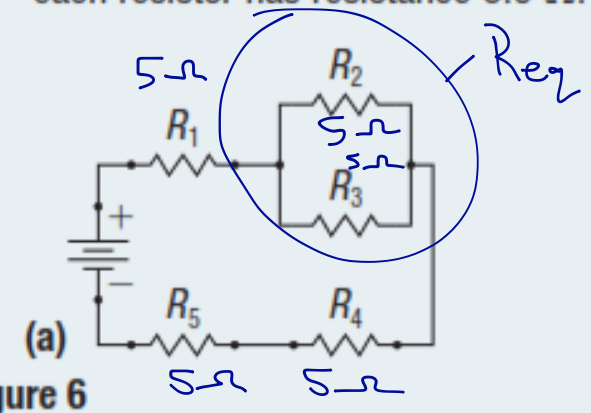
1. What is the total resistance of the mixed circuits shown in **Figure 6**? Note that each resistor has resistance 5.0 Ω. T/I [ans: (a) 17.5 Ω; (b) 6.3 Ω]



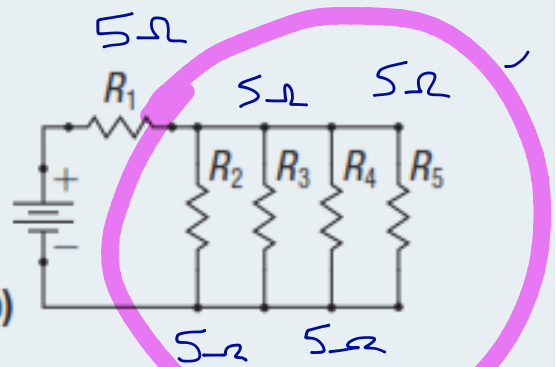


Figure 6

$\frac{1}{R_{eq}} = \frac{1}{5\Omega} + \frac{1}{5\Omega}$

$1/R_{eq} = 2/5\Omega$

$R_{eq} = \frac{5\Omega}{2} = 2.5\Omega$

$R_T = 5\Omega + 2.5\Omega + 5\Omega + 5\Omega$

$R_T = 17.5\Omega$

$\frac{1}{R_{eq}} = \frac{1}{5\Omega} + \frac{1}{5\Omega} + \frac{1}{5\Omega} + \frac{1}{5\Omega}$

$1/R_{eq} = 4/5\Omega$

$R_{eq} = \frac{5\Omega}{4} = 1.25\Omega$

$R_T = 5\Omega + 1.25\Omega$

$R_T = 6.25\Omega$

Work

- Read 11.7, 11.8, and 11.9
- Pg. 527 #2
- Pg. 529 #2
- Pg. 530 #5
- ~~Pg. 535 #1b~~