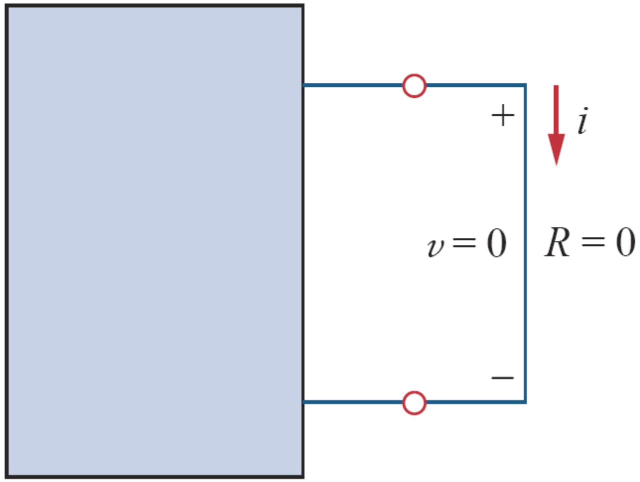
- Ohm’s law states that the voltage v across a resistor is directly proportional to the current i flowing through

$$\boxed{v = iR}$$

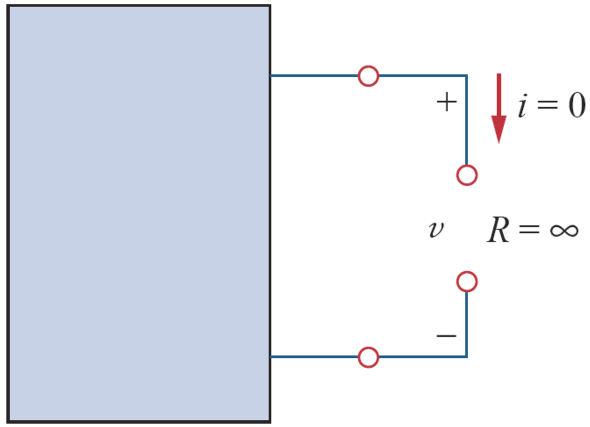
The resistance R of an element denotes its ability to resist the flow of electric current; it is measured in ohms.

$$R = \frac{v}{i}$$



(a)

A short circuit is a circuit element with resistance approaching zero.



(b)

An open circuit is a circuit element with resistance approaching infinity.

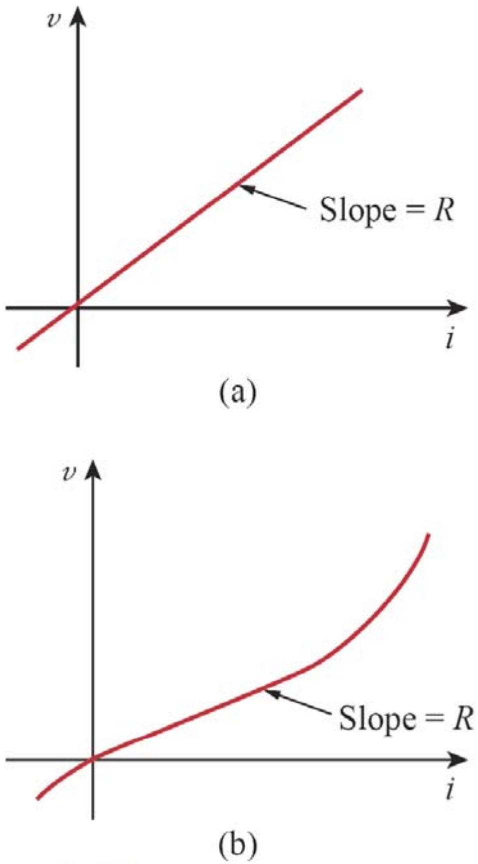
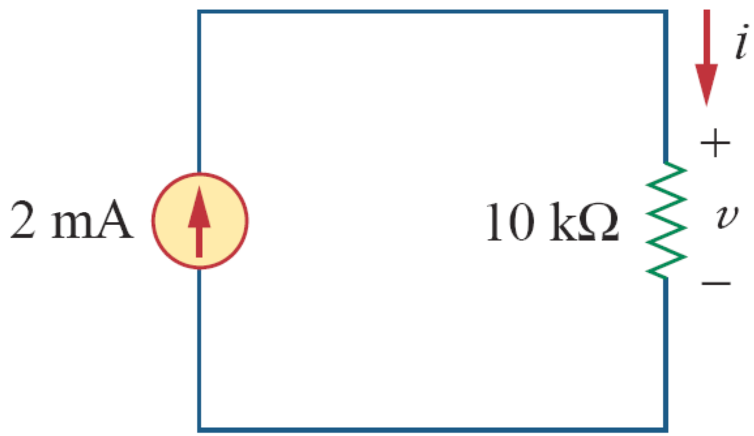


Figure 2.7
The i-v characteristic of: (a) a linear resistor, (b) a nonlinear resistor.

- Conductance is the ability of an element to conduct electric current; it is measured in mhos or siemens (S).



A branch represents a single element such as a voltage source or a resistor.

A node is the point of connection between two or more branches.

A loop is any closed path in a circuit.

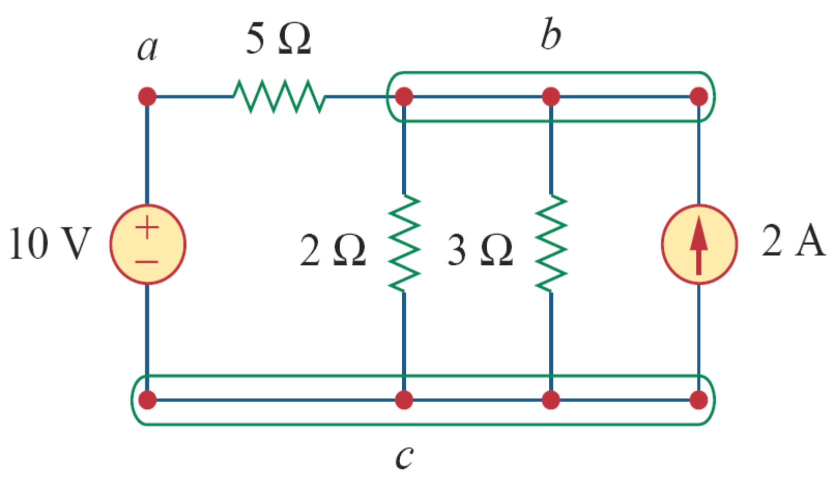


Figure 2.10
Nodes, branches, and loops.

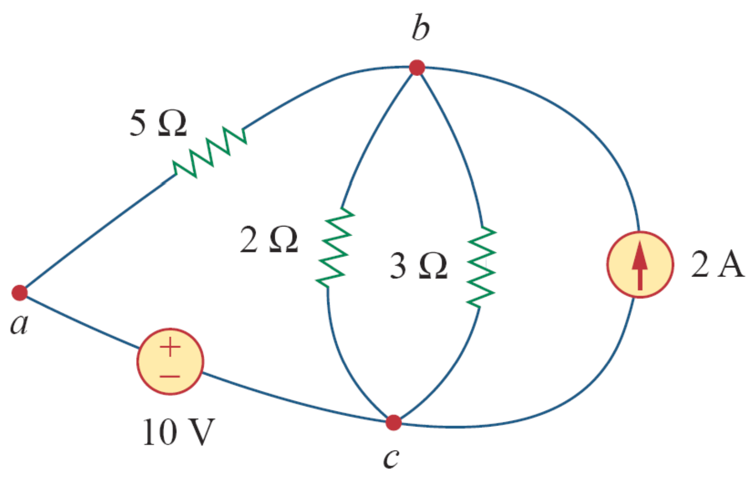


Figure 2.11
The three-node circuit of Fig. 2.10 is redrawn.

- Two or more elements are in series if they exclusively share a single node and consequently carry the same current.
- Two or more elements are in parallel if they are connected to the same two nodes and consequently have the same voltage across them.

Kirchhoff's Laws

- Kirchhoff's current law (KCL) states that the algebraic sum of currents entering a node (or a closed boundary) is zero.

$$\sum_{n=1}^{N} i_n = 0$$

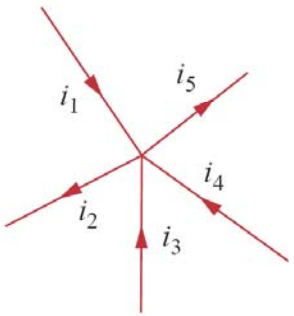


Figure 2.16
Currents at a node illustrating KCL.

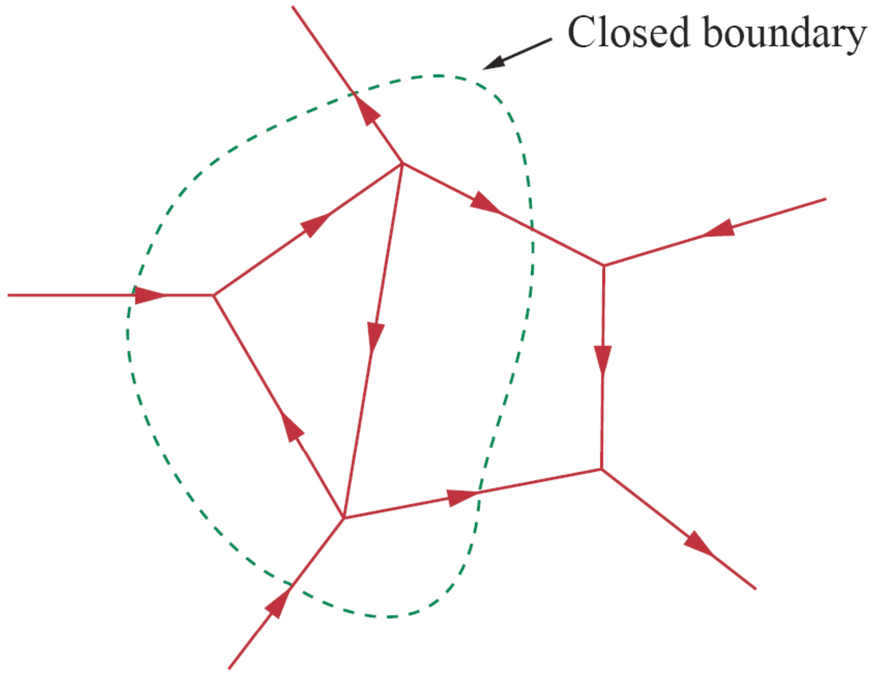


Figure 2.17
Applying KCL to a closed boundary.

- Kirchhoff's voltage law (KVL) states that the algebraic sum of all voltages around a closed path (or loop) is zero.

$$\sum_{m=1}^{M} v_m = 0$$

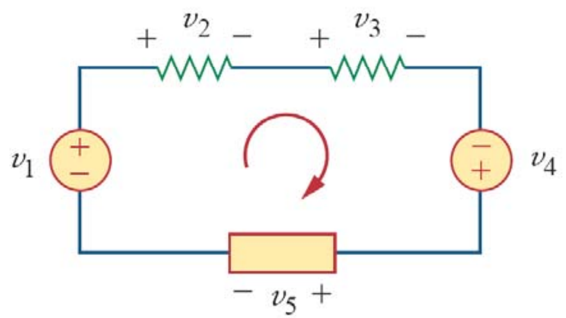


Figure 2.19
A single-loop circuit illustrating KVL.

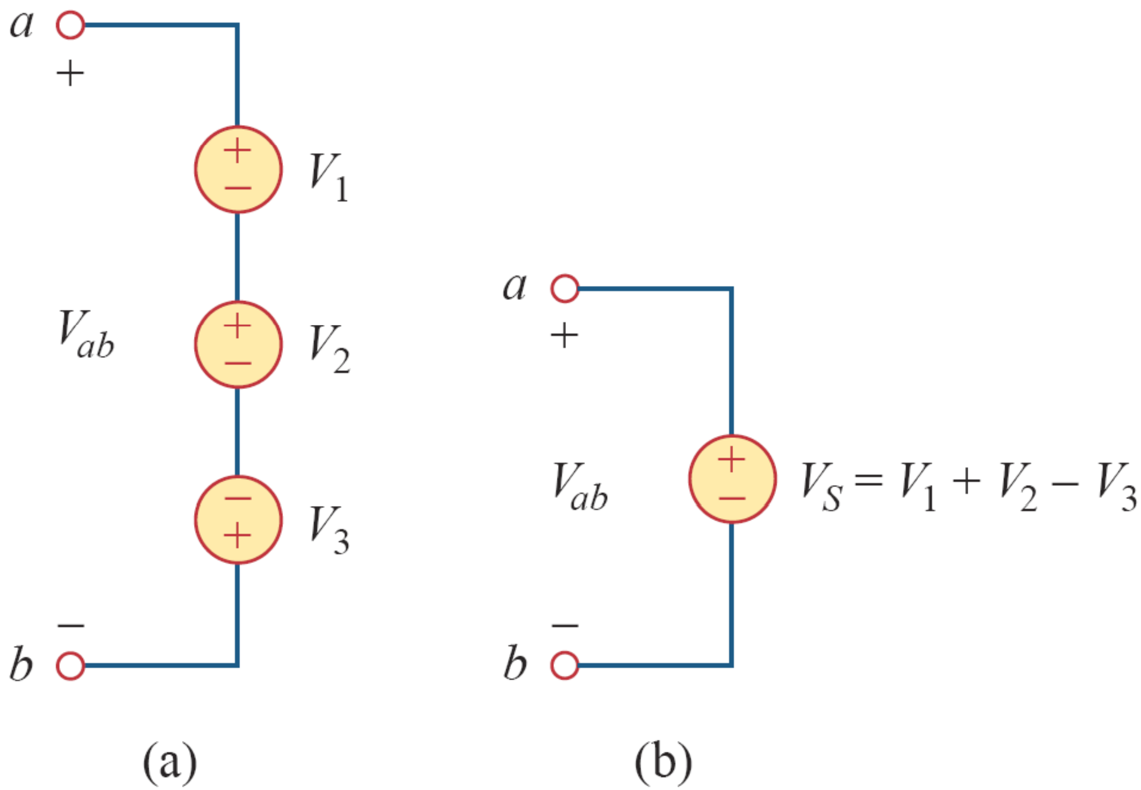


Figure 2.20
Voltage sources in series: (a) original circuit, (b) equivalent circuit.

Determine v_o and i in the circuit shown in Fig. 2.23(a).

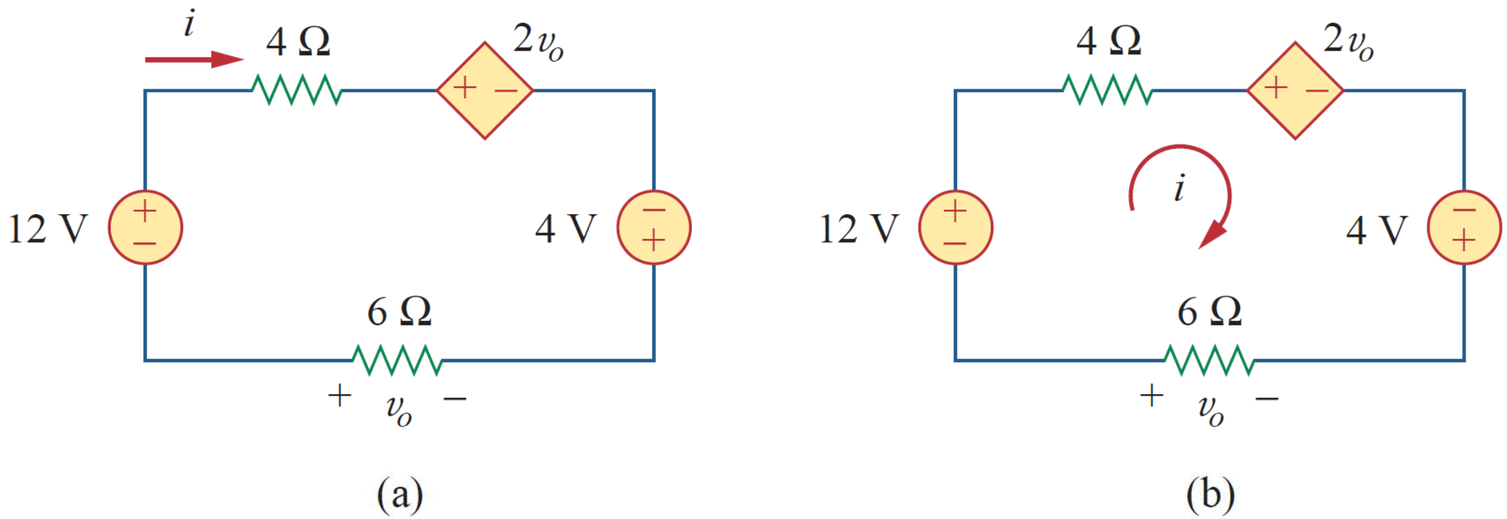
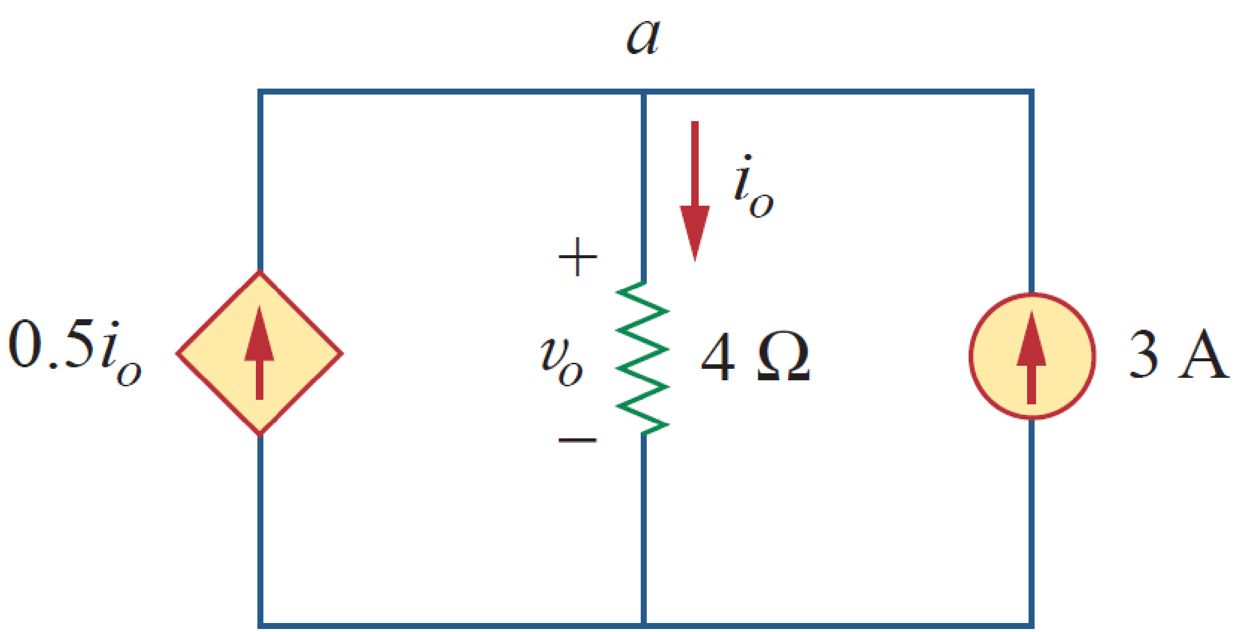


Figure 2.23

Example 2.7



Practice Problem 2.7

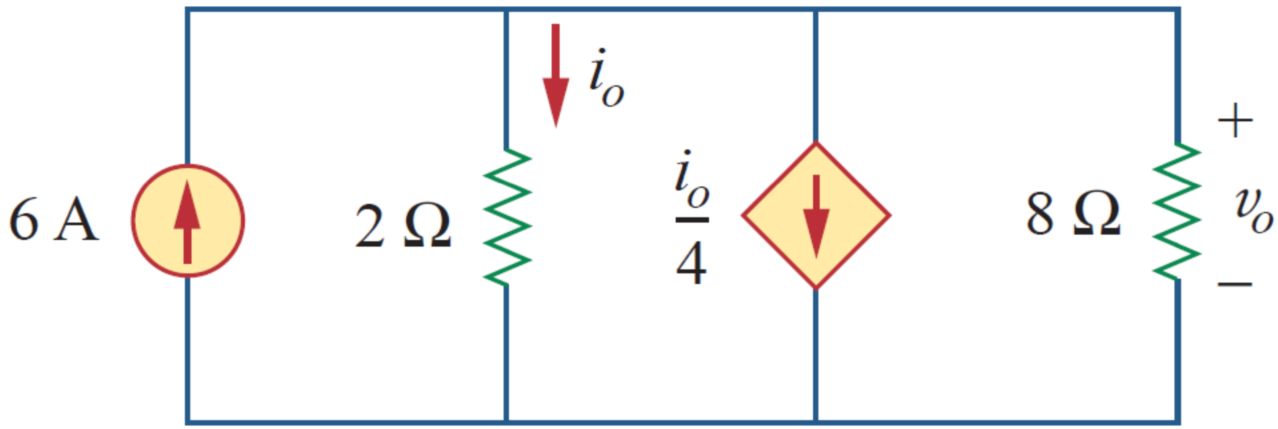
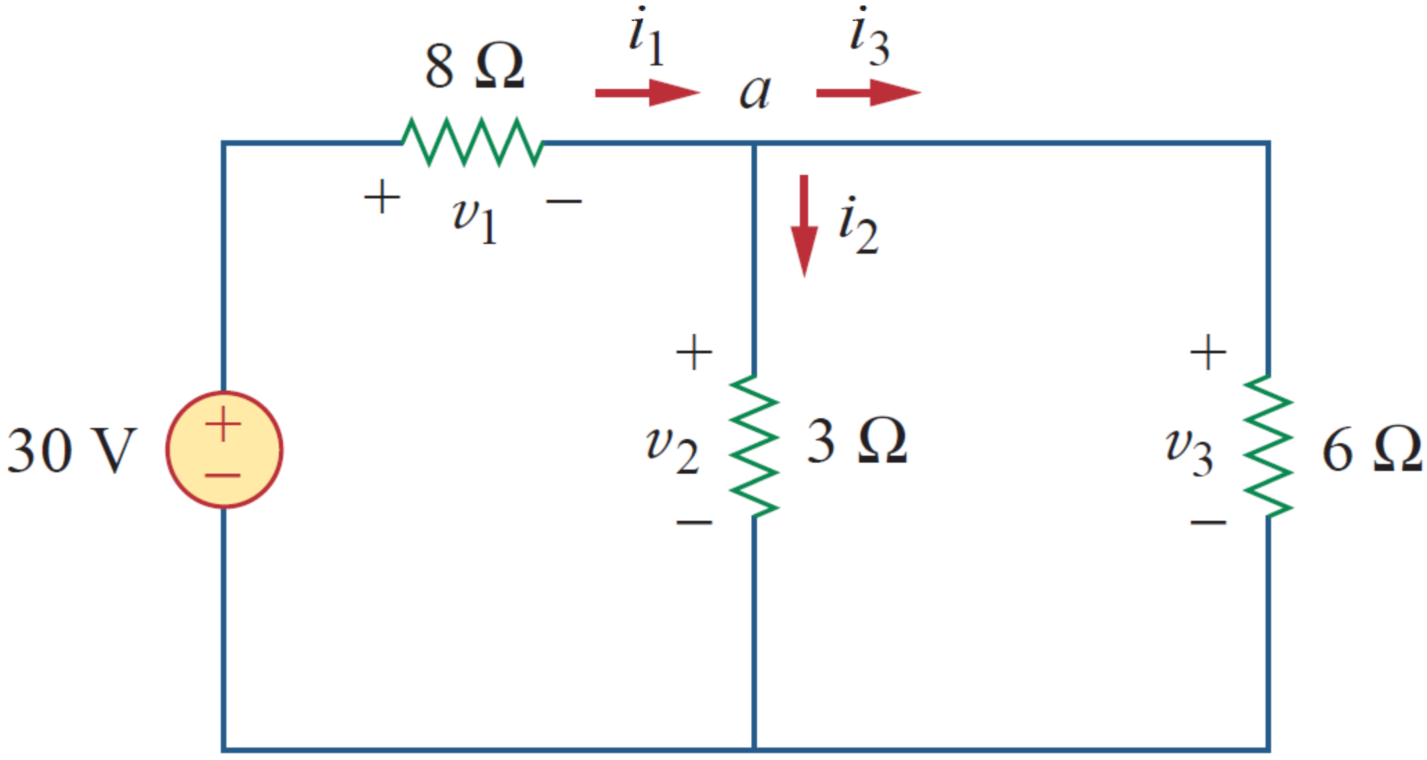
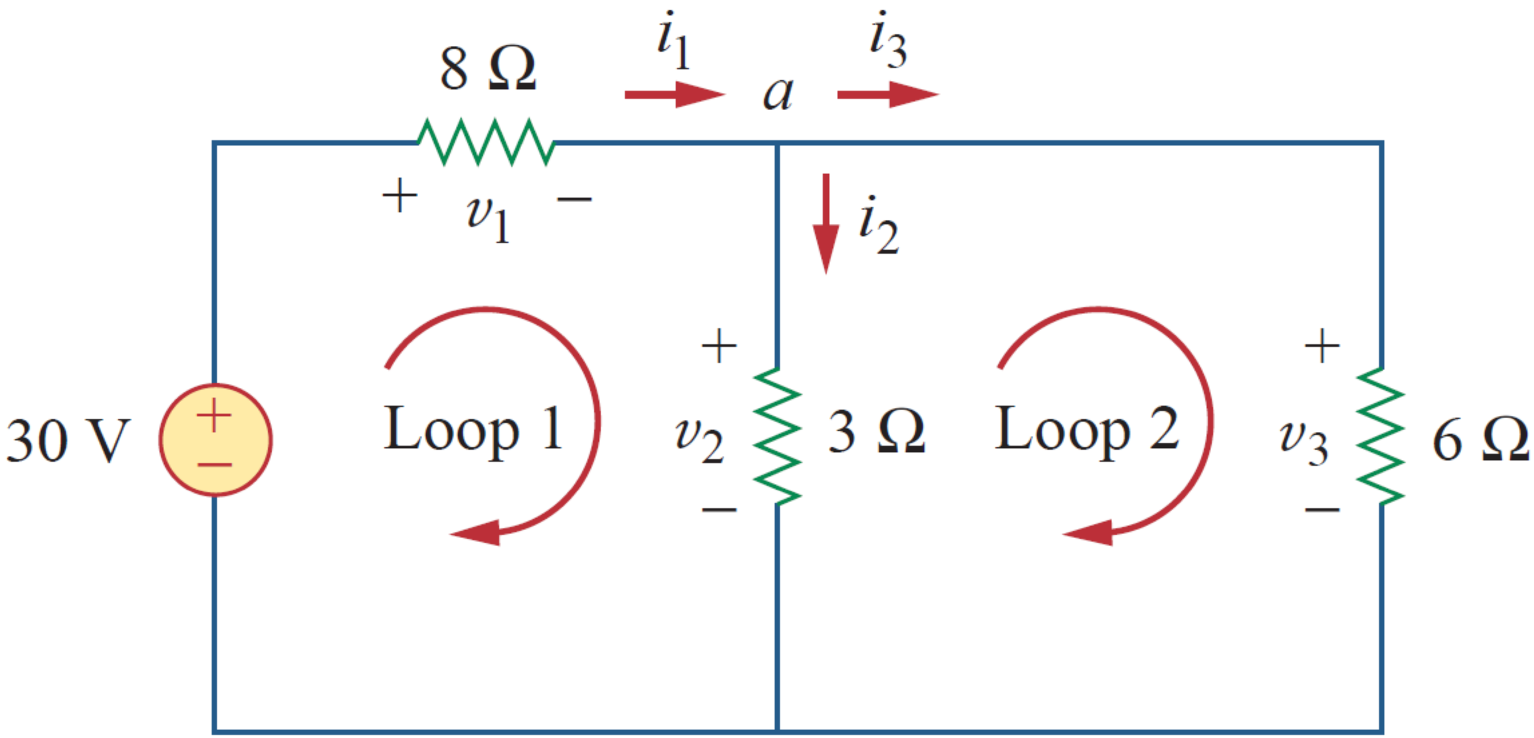


Figure 2.26



(a)

Figure 2.27



(b)

Series Resistors and Voltage Division

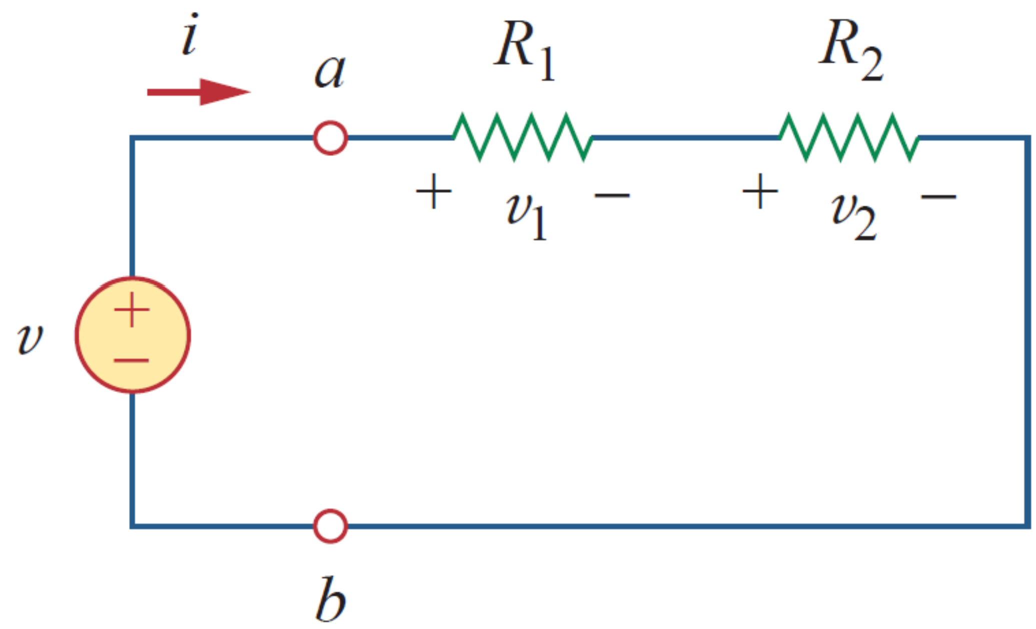


Figure 2.29
A single-loop circuit with two resistors in series.

The equivalent resistance of any number of resistors connected in series is the sum of the individual resistances.

For N resistors in series then,

$$\boxed{R_{eq} = R_1 + R_2 + \cdots + R_N = \sum_{n=1}^{N} R_n} \qquad \textbf{(2.30)}$$

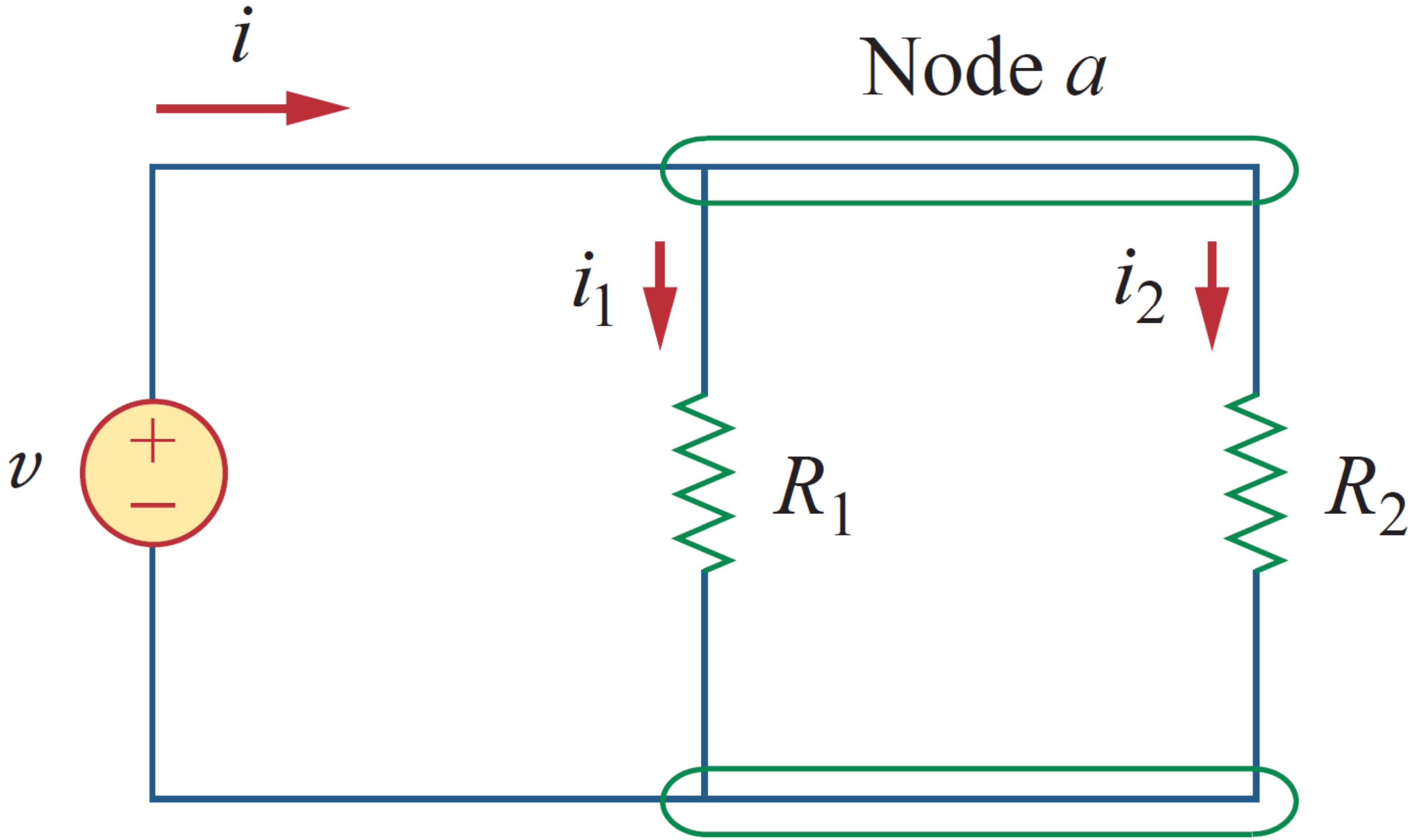
To determine the voltage across each resistor in Fig. 2.29, we substitute Eq. (2.26) into Eq. (2.24) and obtain

$$\boxed{v_1 = \frac{R_1}{R_1 + R_2} v, \qquad v_2 = \frac{R_2}{R_1 + R_2} v} \qquad \textbf{(2.31)}$$

principle of voltage division

$$v_n = \frac{R_n}{R_1 + R_2 + \cdots + R_N} v$$

Parallel Resistors and Current Division
Consider



- The equivalent conductance of resistors connected in parallel is the sum of their individual conductances

$$\boxed{G_{eq} = G_1 + G_2 + G_3 + \cdots + G_N} \qquad \textbf{(2.40)}$$

$$i_n = \frac{G_n}{G_1 + G_2 + \cdots + G_N} i$$