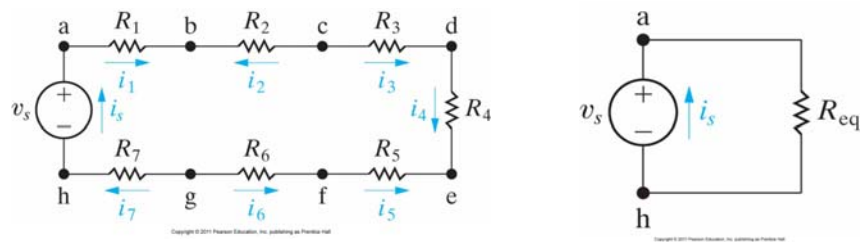# ENG2200
Electric Circuits

Chapter 3
Simple Resistive Circuits

Chapter 3

- Resistance in series and parallel
- Voltage and current dividers
- Measuring voltage, current, and resistance
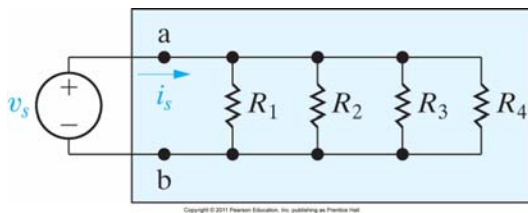- Delta-to-Wye (Δ to Y)

Resistance in Series

- Two or more resistors are connected *in series* if they carry the same current
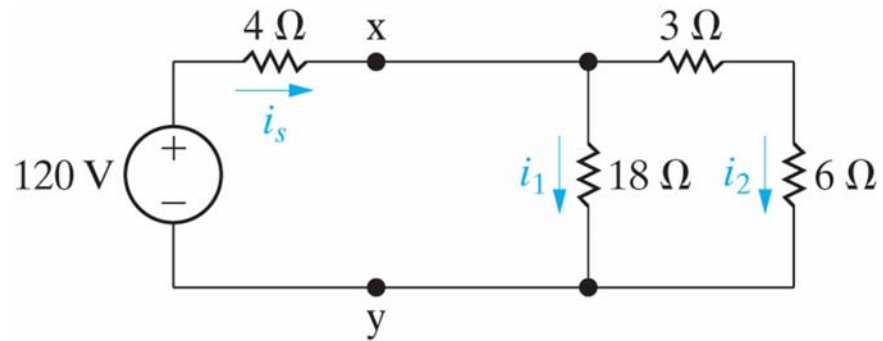- $R_{eq} = R_1 + R_2 + \cdots + R_7$

Resistors in parallel.

- Two, or more, resistors are connected in parallel if they have the same voltage.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$
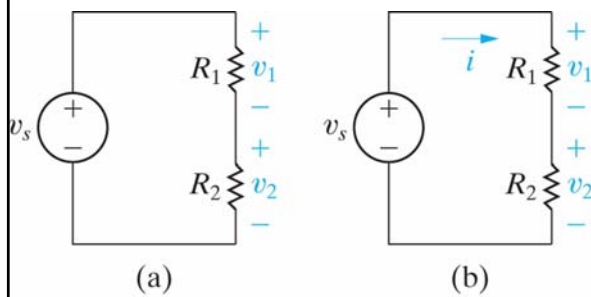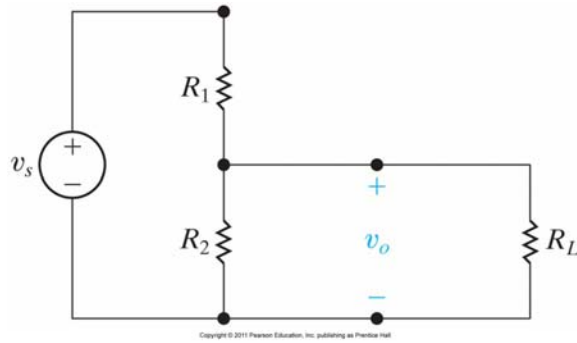
(use conductance)

Find i_s, i_1, and i_2

4 Ω   x   3 Ω

i_s

120 V

i_1 ⟩ 18 Ω i_2 ⟩ 6 Ω

y

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Voltage Divider

What is v_1 and v_2 relative to v_s?

R_1 v_1

v_s

R_2 v_2

i R_1 v_1

v_s

R_2 v_2

(a)   (b)

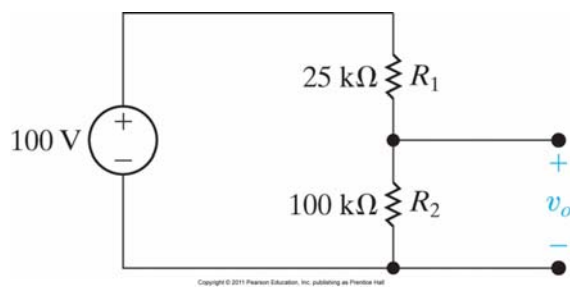Copyright © 2011 Pearson Education, Inc. publishing as Prentice Hall

The effect of loading

The effect of loading
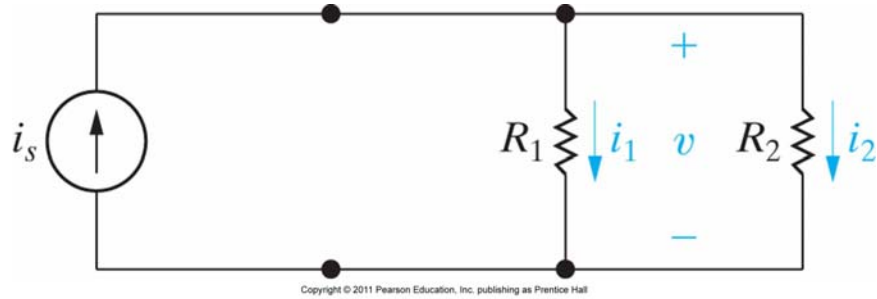
Find v_o

What if the load is 10Ω

What is the load id 10 M Ω

Find i_1 and i_2 in terms of i_s

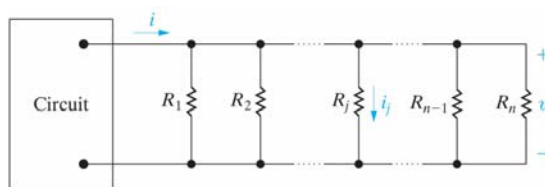Copyright © 2011 Pearson Education, Inc. publishing as Prentice Hall

Find the power dissipated in the 6 Ω resistir

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Voltage and current dividers

R_1 R_2 R_3

$+$
V
$-$

R_j

R_6 R_5 R_4

$$v_j = iR_j = \frac{R_j}{R_{eq}} v$$

Circuit

R_1 R_2 $R_j \downarrow i_j$ R_{n-1} R_n v

$$i_j = \frac{v}{R_j} = \frac{R_{eq}}{R_j} i$$

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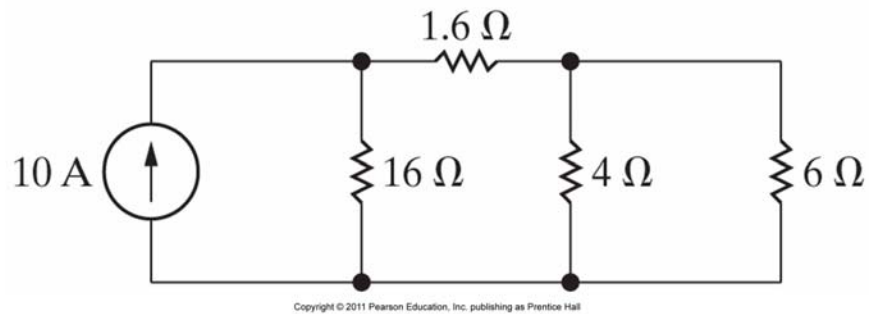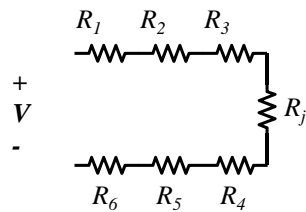
Measuring Voltage and Current

- Voltmeter is an instrument to measure voltage across a load
  - In parallel with the load
  - Ideal resistance of ∞
- Ammeter is an instrument to measure current in a load
  - In series with the load
  - Ideal resistance of 0

D'Arsonval meter movement.
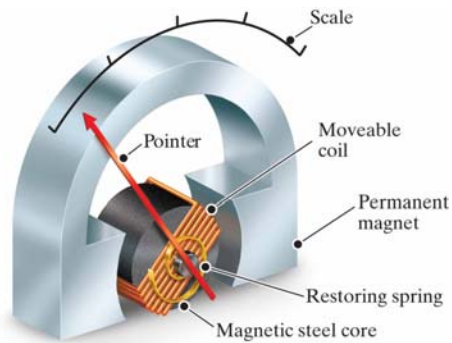
•When current flows in the coil, it creates a torque that rotates the pointer.

•A meter is rated at 50mV and 1mA means when the coil is carrying 1mA there is a voltage drop of 50mV and the pointer full scale

•To use it as an ammeter, a parallel resistor is used

•To use it as voltmeter, a serial resistor is used

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Example

- A 50 mV, 1 mA d'Arsonval movement is used as ammeter with a full scale of 10mA
- What is R_A?
- What measurement will result to if used to measure current in a 100Ω R with 1V across

Example

- A 50 mV, 1 mA d'Arsonval movement is used as Voltmeter with a full scale of 150 V
- What is R_v?
- What measurement will result if used to measure voltage across 75 kΩ R in series with 15 KΩ with v = 60V

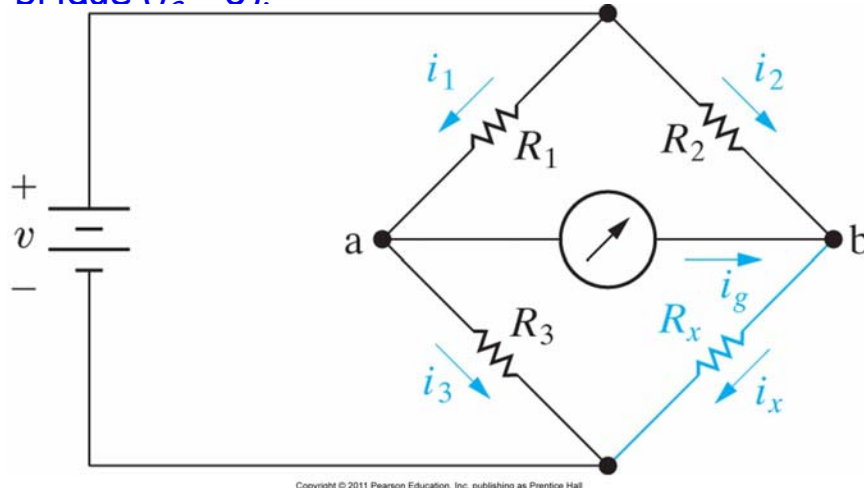**Figure 3.26** The Wheatstone bridge circuit.
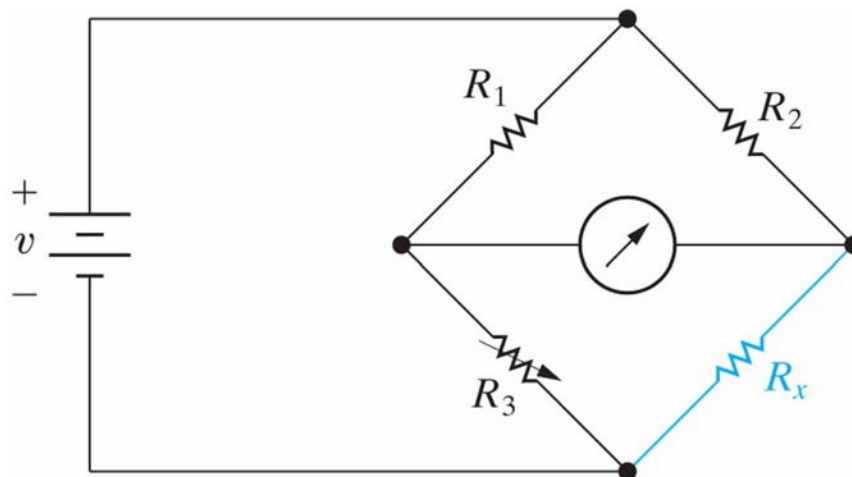
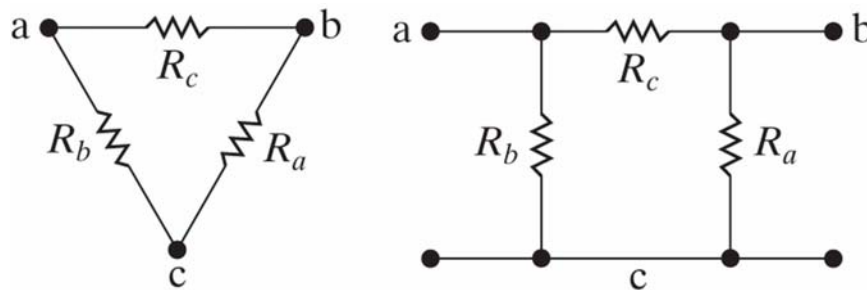**Figure 3.27** A balanced Wheatstone bridge (i_g = 0).

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Figure 3.29 A Δ configuration viewed as a π configuration.

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Figure 3.30 A Y structure viewed as a T structure.
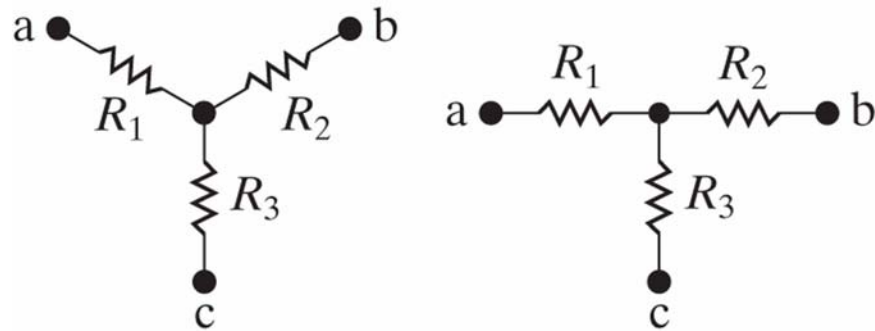
Figure 3.31 The Δ-to-Y transformation.
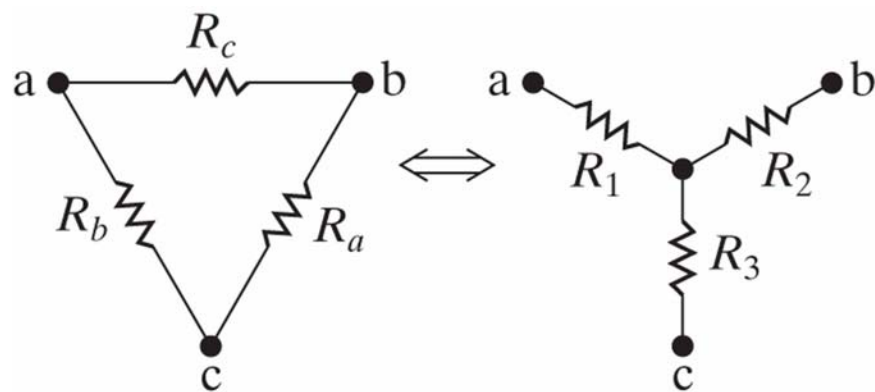
$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$
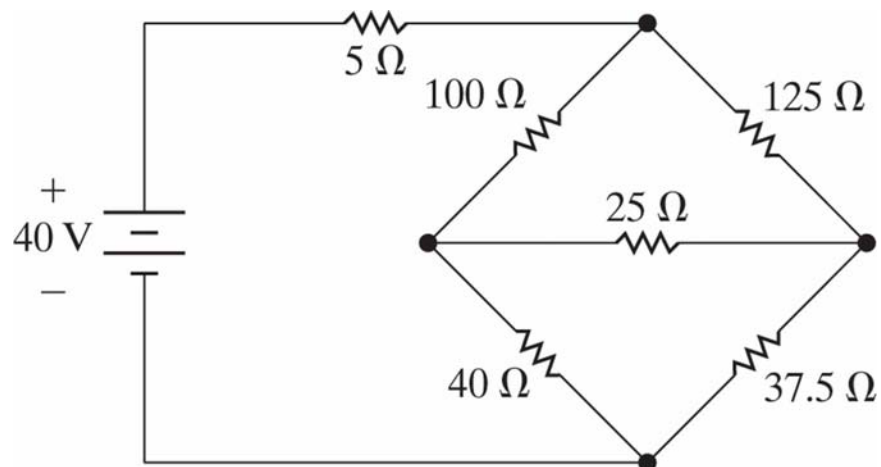
$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

$$Ra = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}$$

$$Rb = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2}$$

$$Rc = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3}$$

Figure 3.32 The circuit for Example 3.7.