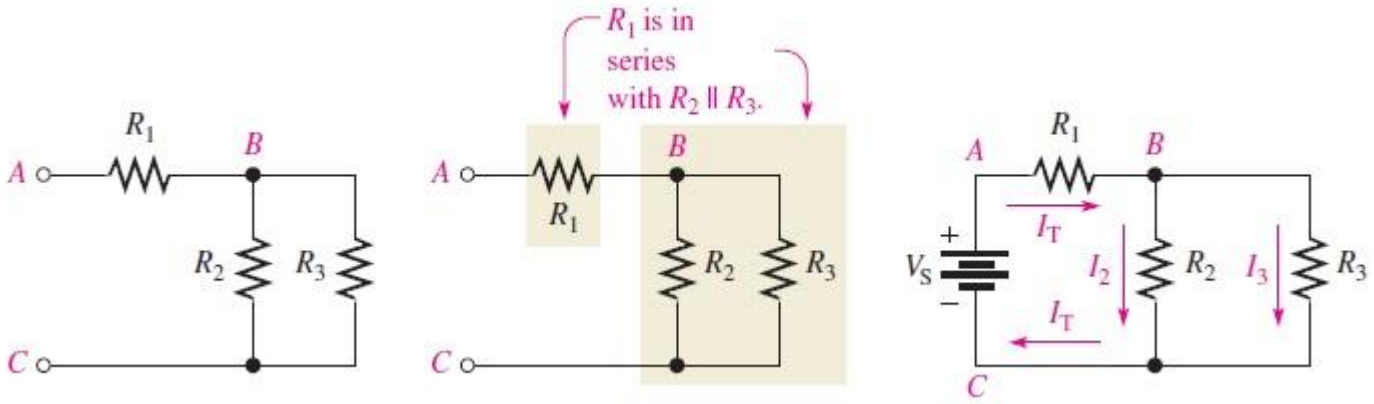
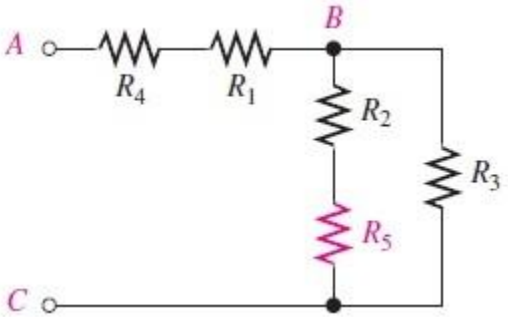
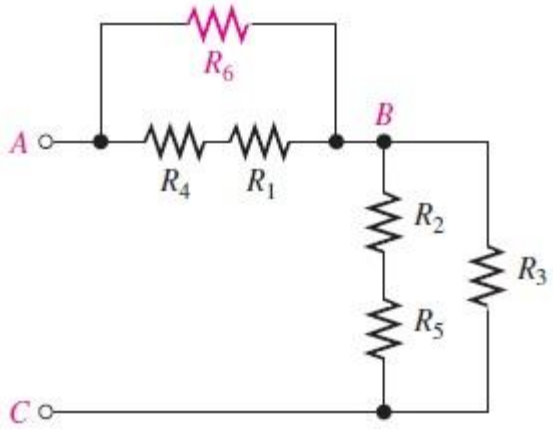
Series-Parallel Resistive Circuits

IDENTIFYING SERIES-PARALLEL RELATIONSHIPS

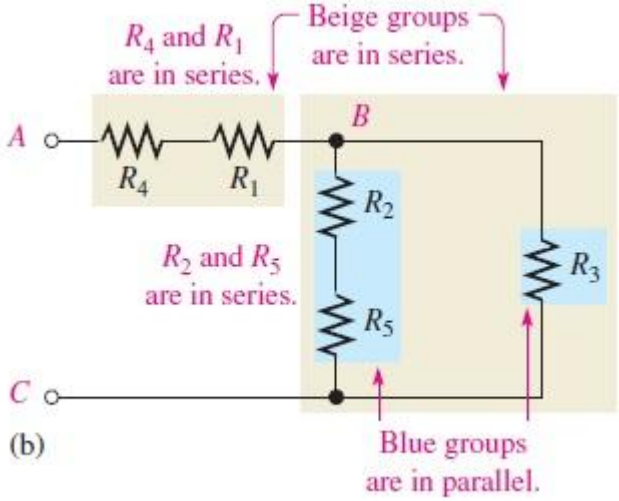
A series-parallel circuit consists of combinations of both series and parallel current paths. It is important to be able to identify how the components in a circuit are arranged in terms of their series and parallel relationships.



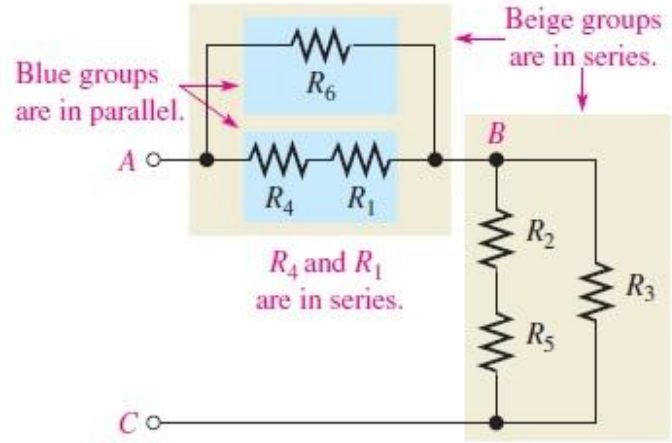

A
B
C
R_4
R_1
R_2
R_3
R_5

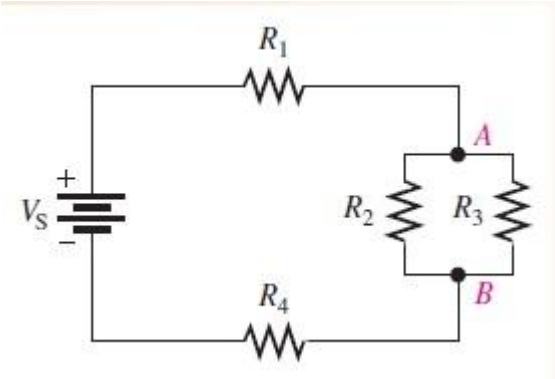

R_6
A
B
C
R_4
R_1
R_2
R_3
R_5

(a)

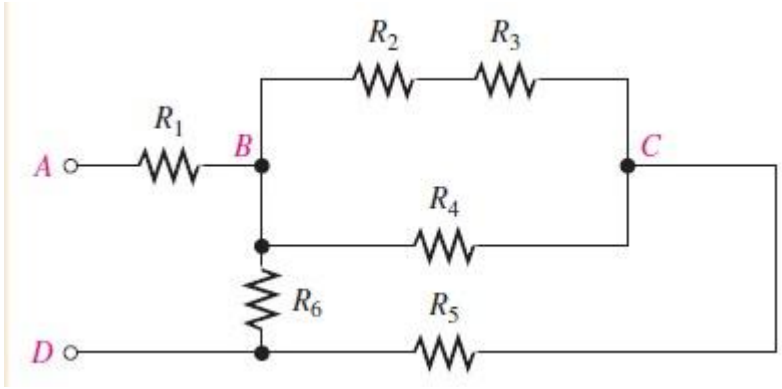

R_4 and R_1 are in series.
Beige groups are in series.
A
B
C
R_4
R_1
R_2
R_3
R_5
R_2 and R_5 are in series.
Blue groups are in parallel.

(b)

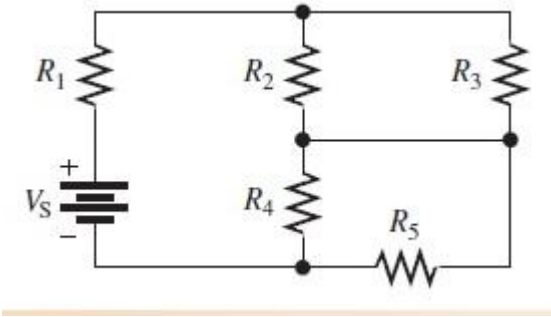

Blue groups are in parallel.
Beige groups are in series.
R_6
A
B
C
R_4
R_1
R_2
R_3
R_5
R_4 and R_1 are in series.



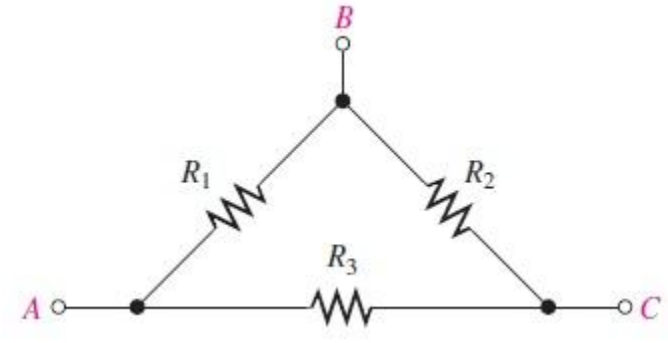
Solution in Class



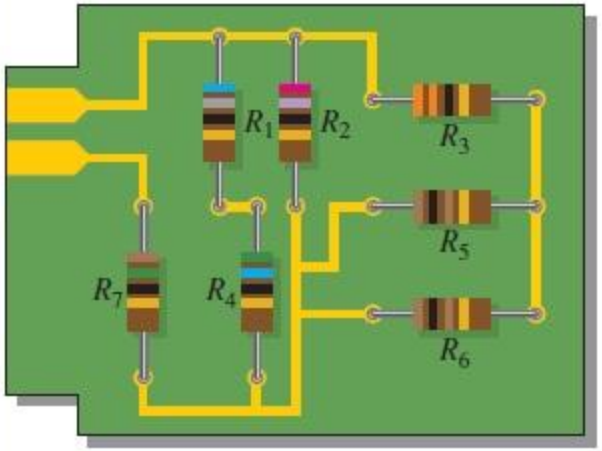
Solution in Class

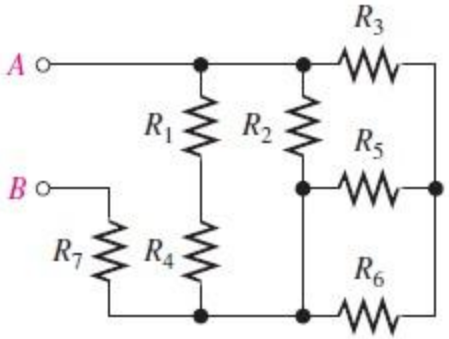


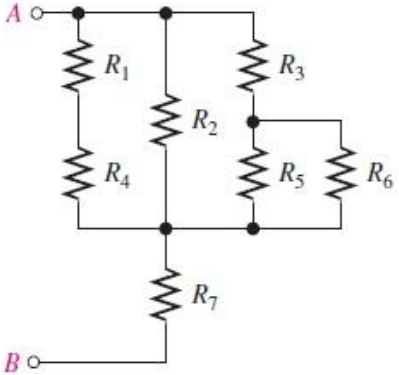
Solution in Class

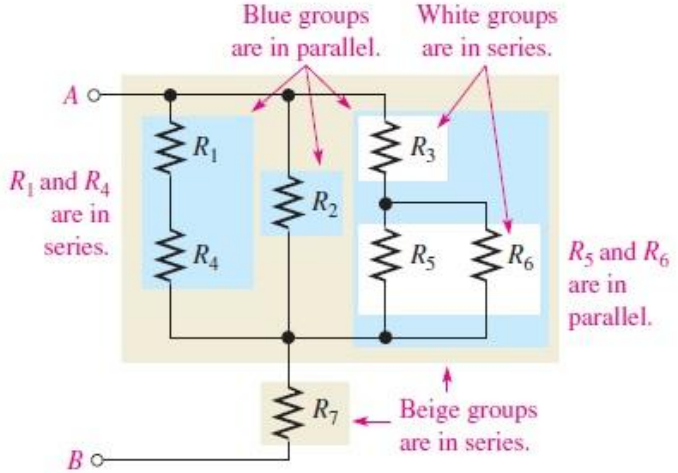


Solution in Class


R_1
R_2
R_3
R_5
R_7
R_4
R_6


A
B
R_1
R_2
R_3
R_5
R_7
R_4
R_6


A
B
R_1
R_2
R_3
R_4
R_5
R_6
R_7


Blue groups are in parallel.
White groups are in series.
A
B
R_1 and R_4 are in series.
R_5 and R_6 are in parallel.
Beige groups are in series.
R_1
R_2
R_3
R_4
R_5
R_6
R_7

ANALYSIS OF SERIES-PARALLEL RESISTIVE CIRCUITS

Analyze series-parallel circuits

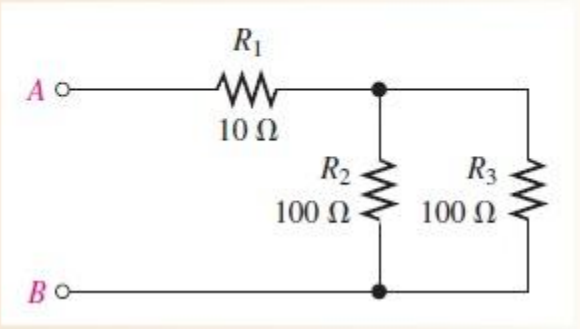
- Determine total resistance
- Determine all the currents
- Determine all the voltage drops

Total Resistance

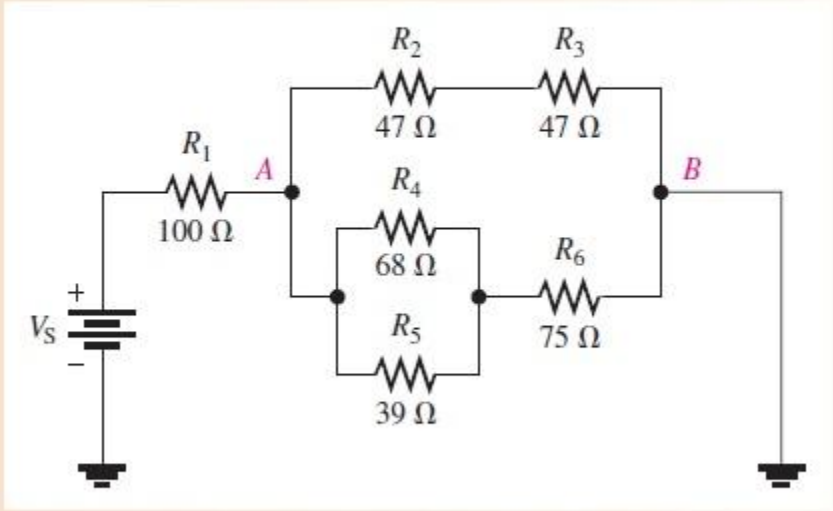
To find the total resistance ( ) of a series-parallel combination, simply define the series and parallel relationships; then perform the calculations that you have previously learned.

Determine R_T of the circuit in Figure 16 between terminals A and B.

▶ FIGURE 16



Find the total resistance between the positive and negative terminals of the battery in Figure 17.



▲ FIGURE 17

Total Current

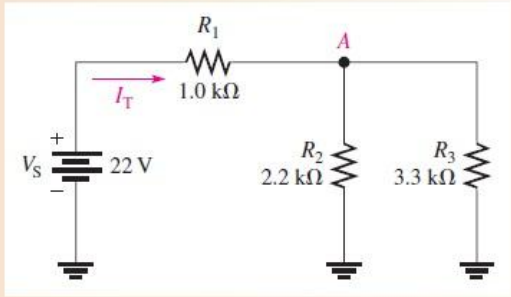
Once you know the total resistance and the source voltage, you can apply Ohm's law to find the total current in a circuit. Total current is the source voltage divided by the total resistance.

$$I_T = \frac{V_S}{R_T}$$

Branch Currents

Using the current-divider formula, Kirchhoff's current law, Ohm's law, or combinations of these, you can find the current in any branch of a series-parallel circuit. In some cases, it may take repeated application of the formula to find a given current.

Find the current through R_2 and the current through R_3 in Figure 19.



▲ FIGURE 19

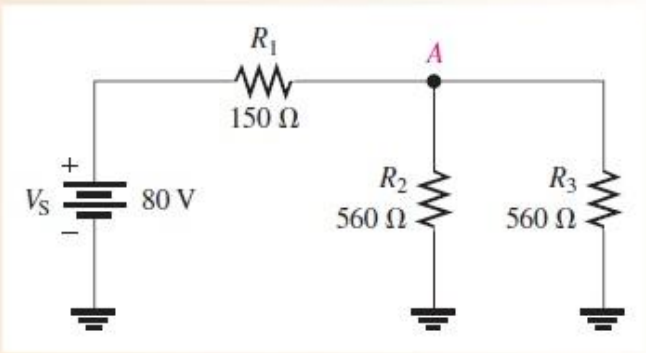
Voltage Drops

To find the voltages across certain parts of a series-parallel circuit, you can use the voltage divider formula, Kirchhoff's voltage law, Ohm's law, or combinations of each.

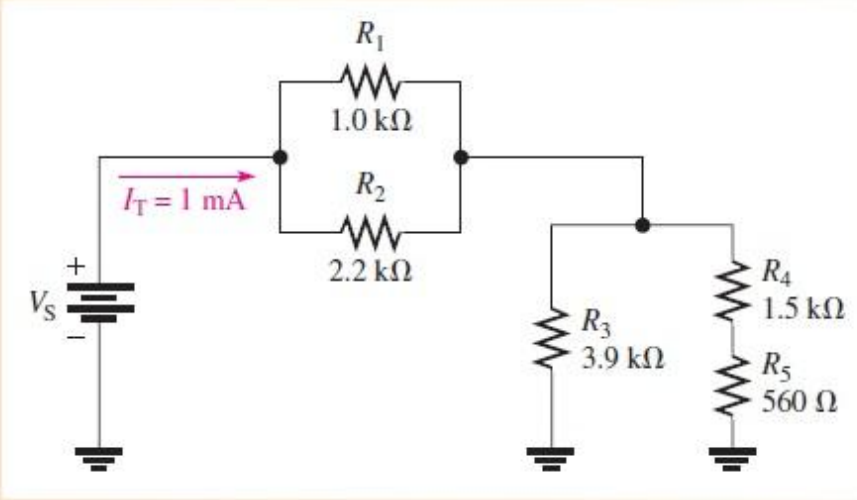
EXAMPLE 10

Determine the voltage drop from node *A* to ground in Figure 21. Then find the voltage (V_1) across R_1.

FIGURE 21



EXAMPLE 11 Determine the voltage drop across each resistor in the circuit of Figure 23.



▲ FIGURE 23