Complex Resistor Combinations

SECTION 3

SECTION OBJECTIVES

- **Calculate the equivalent resistance for a complex circuit involving both series and parallel portions.**
- **Calculate the current in and potential difference across individual elements within a complex circuit.**

RESISTORS COMBINED BOTH IN PARALLEL AND IN SERIES

Series and parallel circuits are not often encountered independent of one another. Most circuits today employ both series and parallel wiring to utilize the advantages of each type.

A common example of a complex circuit is the electrical wiring typical in a home. In a home, a fuse or circuit breaker is connected in series to numerous outlets, which are wired to one another in parallel. An example of a typical household circuit is shown in **Figure 15.**

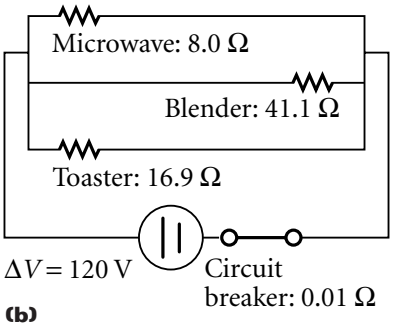
As a result of the outlets being wired in parallel, all the appliances operate independently; if one is switched off, any others remain on. Wiring the outlets in parallel ensures that an identical potential difference exists across any appliance. This way, appliance manufacturers can produce appliances that all use the same standard potential difference.

To prevent excessive current, a fuse or circuit breaker must be placed in series with all of the outlets. Fuses and circuit breakers open the circuit when the current becomes too high. A fuse is a small metallic strip that melts if the current exceeds a certain value. After a fuse has melted, it must be replaced. A circuit breaker, a more modern device, triggers a switch when current reaches a certain value. The switch must be reset, rather than replaced, after the circuit overload has been removed. Both fuses and circuit breakers must be in series with the entire load to prevent excessive current from reaching any appliance. In fact, if all the devices in **Figure 15** were used at once, the circuit would be overloaded. The circuit breaker would interrupt the current.

Fuses and circuit breakers are carefully selected to meet the demands of a circuit. If the circuit is to carry currents as large as 30 A, an appropriate fuse or circuit breaker must be used. Because the fuse or circuit breaker is placed in series with the rest of the circuit, the current in the fuse or circuit breaker is the same as the total current in the circuit. To find this current, one must determine the equivalent resistance.

When determining the equivalent resistance for a complex circuit, you must simplify the circuit into groups of series and parallel resistors and then find the equivalent resistance for each group by using the rules for finding the equivalent resistance of series and parallel resistors.

(a)



(b)

Figure 15

(a) When all of these devices are plugged into the same household circuit, **(b)** the result is a parallel combination of resistors in series with a circuit breaker.