AC Circuits and Transformers

SECTION 3

SECTION OBJECTIVES

- **Distinguish between rms values and maximum values of current and potential difference.**
- **Solve problems involving rms and maximum values of current and emf for ac circuits.**
- **Apply the transformer equation to solve problems involving step-up and step-down transformers.**

EFFECTIVE CURRENT

In the previous section, you learned that an electrical generator could produce an alternating current that varies as a sine wave with respect to time. Commercial power plants use generators to provide electrical energy to power the many electrical devices in our homes and businesses. In this section, we will investigate the characteristics of simple ac circuits.

As with the discussion about direct-current circuits, the resistance, the current, and the potential difference in a circuit are all relevant to a discussion about alternating-current circuits. The emf in ac circuits is analogous to the potential difference in dc circuits. One way to measure these three important circuit parameters is with a digital multimeter, as shown in **Figure 14.** The resistance, current, or emf can be measured by choosing the proper settings on the multimeter and locations in the circuit.

Figure 14
The effective current and emf of an electric circuit can be measured using a digital multimeter.

Effective current and effective emf are measured in ac circuits

An ac circuit consists of combinations of circuit elements and an ac generator or an ac power supply, which provides the alternating current. As shown earlier, the emf produced by a typical ac generator is sinusoidal and varies with time. The induced emf as a function of time (Δv) can be written in terms of the maximum emf (ΔV_{max}), and the emf produced by a generator can be expressed as follows:

$$\Delta v = \Delta V_{max} \sin \omega t$$

A simple ac circuit can be treated as an equivalent resistance and an ac source. In a circuit diagram, the ac source is represented by the symbol , as shown in **Figure 15.**

The instantaneous current that changes with the potential difference can be determined using the definition for resistance. The instantaneous current, i, is related to maximum current by the following expression:

$$i = I_{max} \sin \omega t$$

The rate at which electrical energy is converted to internal energy in the resistor (the power, P) has the same form as in the case of direct current. The electrical energy converted to internal energy at some point in time in a resistor is proportional to the *square* of the instantaneous current and is independent of the direction of the current. However, the energy produced by an alternating current with a maximum value of I_{max} is not the same as that produced by a direct current of the same value. The energies are different because during a cycle, the alternating current is at its maximum value for only an instant.

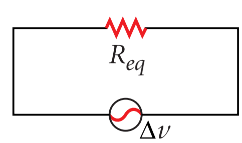

Figure 15
An ac circuit represented schematically consists of an ac source and an equivalent resistance.