TRANSFORMERS

It is often desirable or necessary to change a small ac applied emf to a larger one or to change a large applied emf to a smaller one. The device that makes these conversions possible is the **transformer.**

transformer

a device that increases or decreases the emf of alternating current

In its simplest form, an ac transformer consists of two coils of wire wound around a core of soft iron, like the apparatus for the Faraday experiment. The coil on the left in **Figure 17** has N_1 turns and is connected to the input ac potential difference source. This coil is called the primary winding, or the *primary*. The coil on the right, which is connected to a resistor R and consists of N_2 turns, is the *secondary*. As in Faraday's experiment, the iron core "guides" the magnetic field lines so that nearly all of the field lines pass through both of the coils.

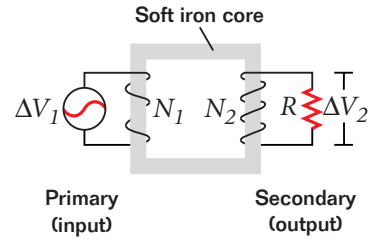

Figure 17
A transformer uses the alternating current in the primary circuit to induce an alternating current in the secondary circuit.

Because the strength of the magnetic field in the iron core and the cross-sectional area of the core are the same for both the primary and secondary windings, the measured ac potential differences across the two windings differ only because of the different number of turns of wire for each. The applied emf that gives rise to the changing magnetic field in the primary is related to that changing field by Faraday's law of induction.

$$\Delta V_1 = -N_1 \frac{\Delta \Phi_M}{\Delta t}$$

Similarly, the induced emf across the secondary coil is

$$\Delta V_2 = -N_2 \frac{\Delta \Phi_M}{\Delta t}$$

Taking the ratio of ΔV_1 to ΔV_2 causes all terms on the right side of both equations except for N_1 and N_2 to cancel. This result is the transformer equation.

TRANSFORMER EQUATION

$$\Delta V_2 = \frac{N_2}{N_1} \Delta V_1$$

$$\textbf{induced emf in secondary} = \left(\frac{\textbf{number of turns in secondary}}{\textbf{number of turns in primary}}\right) \textbf{applied emf in primary}$$

Another way to express this equation is to equate the ratio of the potential differences to the ratio of the number of turns.

$$\frac{\Delta V_2}{\Delta V_1} = \frac{N_2}{N_1}$$

When N_2 is greater than N_1, the secondary emf is greater than that of the primary, and the transformer is called a *step-up transformer*. When N_2 is less than