So what if you need a high-capacitance bipolar capacitor? Here's a trick: place identical high-capacity polarized capacitors **cathode-to-cathode**. What results is effectively a bipolar capacitor with capacitance *half* that of one of the polarized capacitors.

1.7 Inductors

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A **pure inductor** is defined as an element in which **flux linkage** λ—the time integral of the voltage—across the inductor is a monotonic function $\mathcal{F}$ of the current i; i.e. the pure constitutive equation is

$$\lambda = \mathcal{F}(i).$$

An **ideal inductor** is such that this monotonic function is linear, with slope called the **inductance** L; i.e. the ideal constitutive equation is

$$\lambda = Li$$

The units of inductance are the SI derived unit **henry (H)**. Most inductors have inductance best represented in mH or μH.

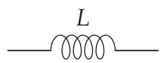

Figure 1.10. Inductor circuit diagram symbol.

The elemental equation for an inductor is found by taking the time-derivative of the constitutive equation. inductor elemental equation

Inductors store energy in a *magnetic field*. It is important to notice how inductors are, in a sense, the *opposite* of capacitors. A capacitor's current is proportional to the time rate of change of its voltage. An inductor's voltage is proportional to the time rate of change of its current.

Inductors are usually made of wire coiled into a number of turns. The geometry of the coil determines its inductance L.

Often, a **core** material—such as iron and ferrite—is included by wrapping the wire around the core. This increases the inductance L.

Inductors are used extensively in radio-frequency (rf) circuits, with which we won't discuss in this text. However, they play important roles in ac-dc conversion, filtering, and transformers—all of which we will consider extensively.

The circuit diagram for an inductor is shown in figure 1.10.

1.8 Problems

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Problem 1.1 CRUMBLE

a. Let two resistors with resistances 1 kΩ and 2 kΩ be connected in series. What is their combined effective resistance?
b. Let two resistors R_1 and R_2 be connected in series. Prove that their combined effective resistance is greater than that of either resistor, individually. Use KVL, KCL, and Ohm's Law.
c. Let two resistors with resistances 1 kΩ and 2 kΩ be connected in parallel. What is their combined effective resistance?
d. Let any two resistors R_1 and R_2 be connected in parallel. Prove that their combined effective resistance is less than that of either resistor, individually. Use KVL, KCL, and Ohm's Law.

Problem 1.2 CORACOMORPH Beginning with the definition of electrical power and the elemental equation of an ideal resistor, find

a. an expression for the power dissipated by a resistor in terms of voltage v_R and resistance R, only; and
b. an expression for the power dissipated by a resistor in terms of current i_R and resistance R, only.

Problem 1.3 MASTICUROUS An unregulated function generator has a 50 Ω output resistance. The front panel displays a nominal voltage amplitude of 10 V, which assumes a matching load of 50 Ω. However, the output is *not* connected to this nominal matching load. Instead, it is connected to an oscilloscope with high input resistance—let's say it's infinite. Respond to the following questions and imperatives about this situation.

a. Draw a circuit diagram.
b. Using the given information about the "nominal" voltage amplitude, determine what the ideal source voltage amplitude V_s should be in your circuit diagram/function generator model.
c. Solve for the actual voltage amplitude v_a at the oscilloscope if the front panel says 5 V amplitude.