PHYSICS APPLIED
Dipoles in molecular biology

TABLE 17–2 Dipole Moments of Selected Molecules

Molecule	Dipole Moment (C · m)
$H_2^{(+)}O^{(-)}$	6.1×10^{-30}
$H^{(+)}Cl^{(-)}$	3.4×10^{-30}
$N^{(-)}H_3^{(+)}$	5.0×10^{-30}
$>N^{(-)}-H^{(+)}$	$\approx 3.0 \times 10^{-30}$ ‡
$>C^{(+)}=O^{(-)}$	$\approx 8.0 \times 10^{-30}$ ‡

‡ These last two groups often appear on larger molecules; hence the value for the dipole moment will vary somewhat, depending on the rest of the molecule.

In many molecules, even though they are electrically neutral, the electrons spend more time in the vicinity of one atom than another, which results in a separation of charge. Such molecules have a dipole moment and are called **polar molecules**. We already saw that water (Fig. 16–4) is a polar molecule, and we have encountered others in our discussion of molecular biology (Section 16–11). Table 17–2 gives the dipole moments for several molecules. The + and − signs indicate on which atoms these charges lie. The last two entries are a part of many organic molecules and play an important role in molecular biology.

17–7 Capacitance

PHYSICS APPLIED
Uses of capacitors

A **capacitor** is a device that can store electric charge, and consists of two conducting objects (usually plates or sheets) placed near each other but not touching. Capacitors are widely used in electronic circuits. They store charge which can later be released, as in a camera flash, and as energy backup in computers if the power fails. Capacitors block surges of charge and energy to protect circuits. Very tiny capacitors serve as memory for the "ones" and "zeroes" of the binary code in the random access memory (RAM) of computers. Capacitors serve many other applications as well, some of which we will discuss.

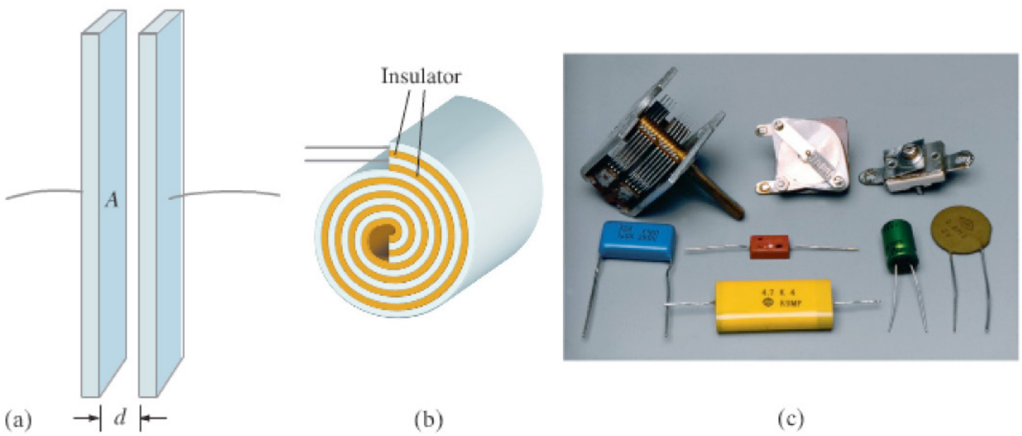
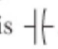
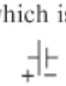


FIGURE 17–13 Capacitors: diagrams of (*a*) parallel plate, (*b*) cylindrical (rolled up parallel plate). (*c*) Photo of some real capacitors.

A simple capacitor consists of a pair of parallel plates of area A separated by a small distance d (Fig. 17–13a). Often the two plates are rolled into the form of a cylinder with paper or other insulator separating the plates, Fig. 17–13b; Fig. 17–13c is a photo of some actual capacitors used for various applications. In a diagram, the symbol

 [capacitor symbol]

represents a capacitor. Another symbol for a capacitor you may encounter is . A battery, which is a source of voltage, is indicated by the symbol

 [battery symbol]

with unequal arms.

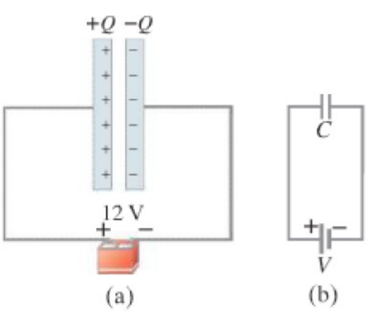


FIGURE 17–14 (*a*) Parallel-plate capacitor connected to a battery. (*b*) Same circuit shown using symbols.

If a voltage is applied across a capacitor by connecting the capacitor to a battery with conducting wires as in Fig. 17–14, the two plates quickly become charged: one plate acquires a negative charge, the other an equal amount of positive charge. Each battery terminal and the plate of the capacitor connected to it are at the same potential; hence the full battery voltage appears across the capacitor. For a given capacitor, it is found that the amount of charge Q acquired by each plate is proportional to the magnitude of the potential difference V between them:

Capacitance

$$Q = CV. \qquad \textbf{(17–7)}$$

The constant of proportionality, C, in Eq. 17–7 is called the **capacitance** of