



(a)



(b)

**FIGURE 1-4** (a) This Roman aqueduct was built 2000 years ago and still stands. (b) Collapse of the Hartford Civic Center in 1978, just two years after it was built.

*Physics applies to many fields*

Early work in electricity that led to the discovery of the electric battery and electric current was done by an eighteenth-century physiologist, Luigi Galvani (1737–1798). He noticed the twitching of frogs’ legs in response to an electric spark and later that the muscles twitched when in contact with two dissimilar metals (Chapter 18). At first this phenomenon was known as “animal electricity,” but it shortly became clear that electric current itself could exist in the absence of an animal.

Physics is used in many fields. A zoologist, for example, may find physics useful in understanding how prairie dogs and other animals can live underground without suffocating. A physical therapist will do a more effective job if aware of the principles of center of gravity and the action of forces within the human body. A knowledge of the operating principles of optical and electronic equipment is helpful in a variety of fields. Life scientists and architects alike will be interested in the nature of heat loss and gain in human beings and the resulting comfort or discomfort. Architects themselves may not have to calculate, for example, the dimensions of the pipes in a heating system or the forces involved in a given structure to determine if it will remain standing (Fig. 1-4). But architects must know the principles behind these analyses in order to make realistic designs and to communicate effectively with engineering consultants and other specialists. From the aesthetic or psychological point of view, too, architects must be aware of the forces involved in a structure—for instability, even if only illusory, can be discomforting to those who must live or work in the structure.

The list of ways in which physics relates to other fields is extensive. In the Chapters that follow we will discuss many such applications as we carry out our principal aim of explaining basic physics.

### **1-3** Models, Theories, and Laws

*Models*

When scientists are trying to understand a particular set of phenomena, they often make use of a **model**. A model, in the scientific sense, is a kind of analogy or mental image of the phenomena in terms of something else we are already familiar with. One example is the wave model of light. We cannot see waves of light as we can water waves. But it is valuable to think of light as if it were made up of waves, because experiments indicate that light behaves in many respects as water waves do.