



FIGURE 2-2. In ancient times, water clocks, called clepsydras, were used for keeping time. The water clock in the photograph is in the Children's Museum, Indianapolis, Indiana.

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The National Institute of Standards and Technology was formerly known as the National Bureau of Standards.

In the 20th century, physicists found that light could be used to make very precise measurements of distances. In 1960, the meter was redefined as a multiple of a wavelength of light emitted by krypton-86. By 1982, an even more precise length measurement defined the meter as the distance light travels in $1/299\,792\,458$ second in a vacuum.

The third standard unit measures the mass of an object. The **kilogram** (kg) is the only unit not defined in terms of the properties of atoms. It is the mass of a platinum-iridium metal cylinder kept near Paris. A copy is kept at the NIST.

Two other fundamental units will be introduced as needed in the text. A wide variety of other units, called **derived units**, are combinations of the fundamental units. A common derived unit is the meter per second, or m/s , used to measure speed.

The SI unit of length is the meter, defined as the distance light travels in a certain amount of time.

The SI unit of mass is the kilogram.

Scientific Notation

Scientists often work with very large and very small quantities. For example, the mass of Earth is about

6 000 000 000 000 000 000 000 kilograms

and the mass of an electron is

0.000 000 000 000 000 000 000 000 911 kilograms.

Written in this form, the quantities take up much space and are difficult to use in calculations. To work with such numbers more easily, we write them in a shortened form by expressing decimal places as powers of ten. This method of expressing numbers is called exponential notation. **Scientific notation** is based on exponential notation. In scientific notation, the numerical part of a measurement is expressed as a number between 1 and 10 multiplied by a whole-number power of 10.

$$M \times 10^n$$

In this expression, $1 \leq M < 10$ and n is an integer. For example, 2000 meters can be written 2×10^3 m. The mass of a softball is about 180 g or 1.8×10^{-1} kg.



FIGURE 2-3. Most countries now use the SI unit *joule* rather than *calorie* for energy.