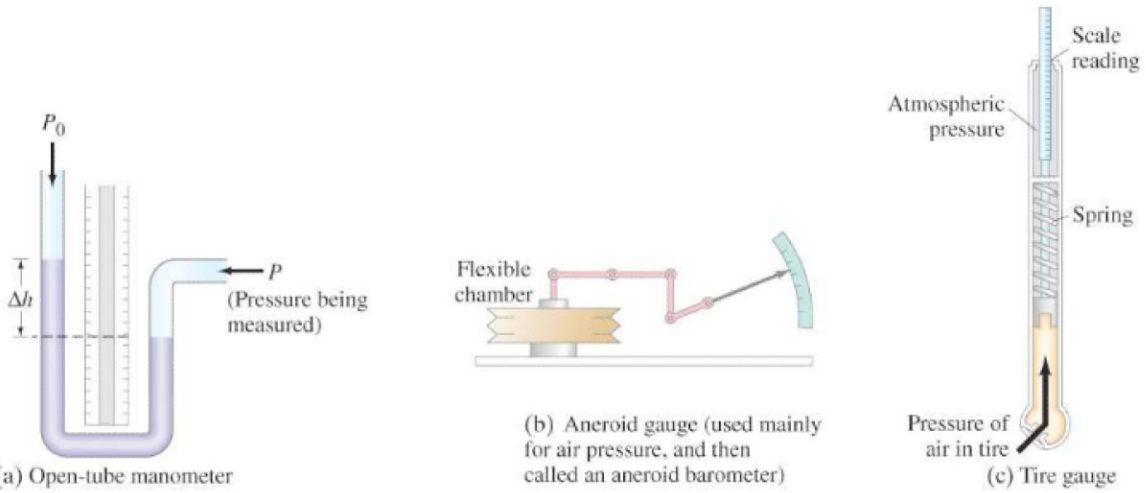

FIGURE 10–8 Pressure gauges: (a) open-tube manometer, (b) aneroid gauge, and (c) common tire pressure gauge.

height Δh of the two levels of the liquid by the relation

$$P = P_0 + \rho g\,\Delta h, \qquad \textbf{(10–3c)}$$

Pressure beneath surface of liquid open to the atmosphere

where P_0 is atmospheric pressure (acting on the top of the liquid in the left-hand tube), and ρ is the density of the liquid. Note that the quantity $\rho g\,\Delta h$ is the gauge pressure—the amount by which P exceeds atmospheric pressure P_0. If the liquid in the left-hand column were lower than that in the right-hand column, P would have to be less than atmospheric pressure (and Δh would be negative).

Instead of calculating the product $\rho g\,\Delta h$, sometimes only the change in height Δh is specified. In fact, pressures are sometimes specified as so many "millimeters of mercury" (mm-Hg) or "mm of water" (mm-H_2O). The unit mm-Hg is equivalent to a pressure of 133 N/m^2, since $\rho g\,\Delta h$ for 1 mm $= 1.0 \times 10^{-3}$ m of mercury gives

$$\rho g\,\Delta h = (13.6 \times 10^3\ \text{kg/m}^3)(9.80\ \text{m/s}^2)(1.00 \times 10^{-3}\ \text{m}) = 1.33 \times 10^2\ \text{N/m}^2.$$

The unit mm-Hg is also called the **torr** in honor of Evangelista Torricelli (1608–1647), a student of Galileo's who invented the barometer (see below). Conversion factors among the various units of pressure (an incredible nuisance!) are given in Table 10–2. It is important that only $N/m^2 = Pa$, the proper SI unit, be used in calculations involving other quantities specified in SI units.

The torr (unit of pressure)

➥ **PROBLEM SOLVING**

Use SI unit in calculations: 1 Pa = 1 N/m^2

Another type of pressure gauge is the aneroid gauge (Fig. 10–8b) in which the pointer is linked to the flexible ends of an evacuated thin metal chamber. In an electronic gauge, the pressure may be applied to a thin metal diaphragm whose resulting distortion is translated into an electrical signal by a transducer. How a common tire gauge is constructed is shown in Fig. 10–8c.

TABLE 10–2 Conversion Factors Between Different Units of Pressure

In Terms of 1 Pa = 1 N/m^2	1 atm in Different Units
1 atm $= 1.013 \times 10^5\ N/m^2$	1 atm $= 1.013 \times 10^5\ N/m^2$
$= 1.013 \times 10^5$ Pa $= 101.3$ kPa	
1 bar $= 1.000 \times 10^5\ N/m^2$	1 atm = 1.013 bar
1 dyne/cm^2 $= 0.1\ N/m^2$	1 atm $= 1.013 \times 10^6$ dyne/cm^2
1 lb/$in.^2$ $= 6.90 \times 10^3\ N/m^2$	1 atm = 14.7 lb/$in.^2$
1 lb/ft^2 $= 47.9\ N/m^2$	1 atm $= 2.12 \times 10^3$ lb/ft^2
1 cm-Hg $= 1.33 \times 10^3\ N/m^2$	1 atm = 76 cm-Hg
1 mm-Hg $= 133\ N/m^2$	1 atm = 760 mm-Hg
1 torr $= 133\ N/m^2$	1 atm = 760 torr
1 mm-H_2O (4°C) $= 9.81\ N/m^2$	1 atm $= 1.03 \times 10^4$ mm-H_2O (4°C)