The Ideal Gas Law

You have learned about equations describing the relationships between two or three of the four variables—pressure, volume, temperature, and moles—needed to describe a gas sample. All the gas laws you have learned thus far can be combined into a single equation. *The* **ideal gas law** *is the mathematical relationship among pressure, volume, temperature, and the number of moles of a gas.* It is the equation of state for an ideal gas, because the state of a gas can be defined by its pressure, volume, temperature, and number of moles. It is stated as shown below, where R is a constant.

$$PV = nRT$$

The ideal gas law reduces to Boyle's law, Charles's law, Gay-Lussac's law, or Avogadro's law when the appropriate variables are held constant.

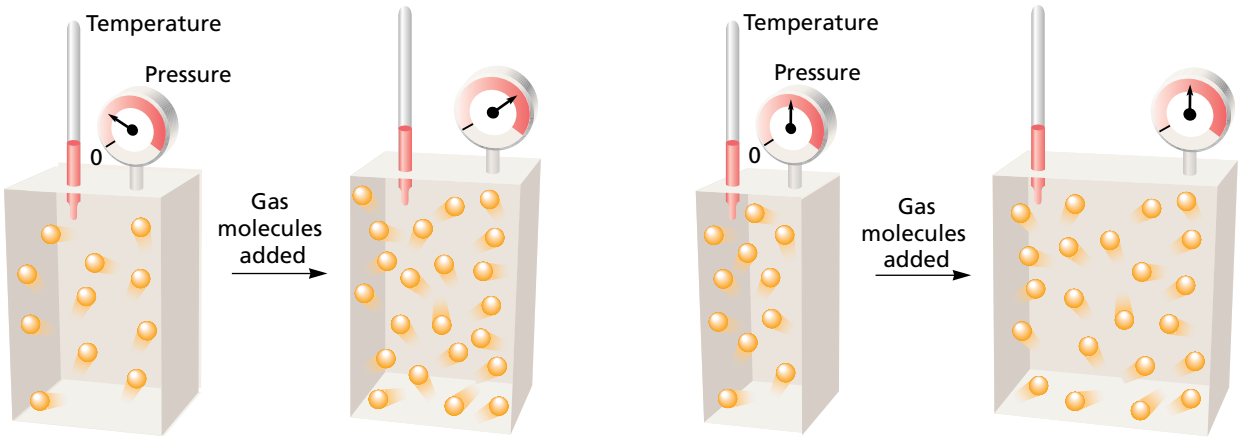
The number of molecules or moles present will always affect at least one of the other three quantities. The collision rate of molecules per unit area of container wall depends on the number of molecules present. If the number of molecules is increased for a sample at constant volume and temperature, the collision rate increases. Therefore, the pressure increases, as shown by the model in **Figure 13a.** Consider what would happen if the pressure and temperature were kept constant while the number of molecules increased. According to Avogadro's law, the volume would increase. As **Figure 13b** shows, an increase in volume keeps the pressure constant at constant temperature. Increasing the volume keeps the collision rate per unit of wall area constant.

extension

Chemical Content

Go to **go.hrw.com** for more information on how the ideal gas law can be derived from Boyle's law, Charles's law, and Avogadro's law.

Keyword: HC6GASX



(a) (b)

FIGURE 13 (a) When volume and temperature are constant, gas pressure increases as the number of molecules increases. (b) When pressure and temperature are constant, gas volume increases as the number of molecules increases.