extension

Chemical Content

Go to **go.hrw.com** for information on how the ideal gas law can be formulated in terms of molar mass and density.

Keyword: HC6GASX

The Ideal Gas Constant

In the equation representing the ideal gas law, *the constant R is known as the* **ideal gas constant.** Its value depends on the units chosen for pressure, volume, and temperature. Measured values of *P, V, T,* and *n* for a gas at near-ideal conditions can be used to calculate *R*. Recall that the volume of one mole of an ideal gas at STP (1 atm and 273.15 K) is 22.414 10 L. Substituting these values and solving the ideal gas law equation for *R* gives the following.

$$R = \frac{PV}{nT} = \frac{(1\ \text{atm})(22.414\ 10\ \text{L})}{(1\ \text{mol})(273.15\ \text{K})} = 0.082\ 058\ \frac{\text{L}\bullet\text{atm}}{\text{mol}\bullet\text{K}}$$

This calculated value of *R* is usually rounded to 0.0821 L • atm/(mol•K). Use this value in ideal gas law calculations when the volume is in liters, the pressure is in atmospheres, and the temperature is in kelvins. See **Table 2** for the value of *R* when other units for *n, P, V,* and *T* are used.

Finding P, V, T, or n from the Ideal Gas Law

The ideal gas law can be applied to determine the existing conditions of a gas sample when three of the four variables, *P, V, T,* and *n,* are known. It can also be used to calculate the molar mass or density of a gas sample.

Be sure to match the units of the known quantities and the units of *R*. In this book, you will be using $R = 0.0821$ L•atm/(mol•K). Your first step in solving any ideal gas law problem should be to check the known values to be sure you are working with the correct units. If necessary, you must convert volumes to liters, pressures to atmospheres, temperatures to kelvins, and masses to numbers of moles before using the ideal gas law.

TABLE 2 Numerical Values of Gas Constant, *R*

Unit of *R*	Numerical value of *R*	Unit of *P*	Unit of *V*	Unit of *T*	Unit of *n*
$\frac{\text{L}\bullet\text{mm Hg}}{\text{mol}\bullet\text{K}}$	62.4	mm Hg	L	K	mol
$\frac{\text{L}\bullet\text{atm}}{\text{mol}\bullet\text{K}}$	0.0821	atm	L	K	mol
$\frac{\text{J}}{\text{mol}\bullet\text{K}}$ *	8.314	Pa	m^3	K	mol
$\frac{\text{L}\bullet\text{kPa}}{\text{mol}\bullet\text{K}}$	8.314	kPa	L	K	mol

Note: 1 L•atm = 101.325 J; 1 J = 1 Pa•m^3

* SI units