Ideal Gas Equation

Volume (V), pressure (P), temperature (T), and moles (n) are four interdependent measures used to indicate the amount of a gas. The relationship between these four measures can be expressed as an equation by adding the gas constant (R):

\[ PV = nRT \]

\[ R = 0.08206 \text{ L} \cdot \text{atm} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \]

(not required to memorize R)

The units of the gas constant (L atm/mol K) require that the V, P, T, and n in calculations be in units of Liters (not mL), atmospheres (not torr, or psi), Kelvin (not °C or °F), and moles (not grams). This may require converting the number given in the problem into the appropriate unit (ex. torr —> atm: relationship 760torr = 1atm) before using the ideal gas equation.

Try working each of the following problems without looking at the answer.

What is the pressure of 0.739 moles of gas in a 2.00 L bottle at 25°C?

\[ P = \frac{nRT}{V} \]

\[ P = \frac{0.739 \text{ mol} \cdot 0.08206 \text{ L} \cdot \text{atm} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \cdot 298 \text{ K}}{2.00 \text{ L}} = 9.0357 \text{ atm} \]

What is the volume of a balloon containing 4.82 moles of gas at 563 torr and 125 K?

\[ V = \frac{nRT}{P} \]

\[ V = \frac{4.82 \text{ mol} \cdot 0.08206 \text{ L} \cdot \text{atm} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \cdot 125 \text{ K}}{0.741 \text{ atm}} = 66.7222 \text{ L} \]

How many moles of gas will fit into a 350 mL bottle at 5.71 atm and 295 K?

\[ n = \frac{PV}{RT} \]

\[ n = \frac{5.71 \text{ atm} \cdot 0.350 \text{ L}}{0.08206 \text{ L} \cdot \text{atm} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \cdot 295 \text{ K}} = 0.082556 = 0.0826 \text{ mol} \]

What is the temperature of 18.9 g of O₂ gas in a 12.7 L bottle at 1.53 atm?

\[ T = \frac{PV}{nR} \]

\[ T = \frac{1.53 \text{ atm} \cdot 12.7 \text{ L}}{0.591 \text{ mol} \cdot 0.08206 \text{ L} \cdot \text{atm} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}} = 400.66 = 401 \text{ K} \]