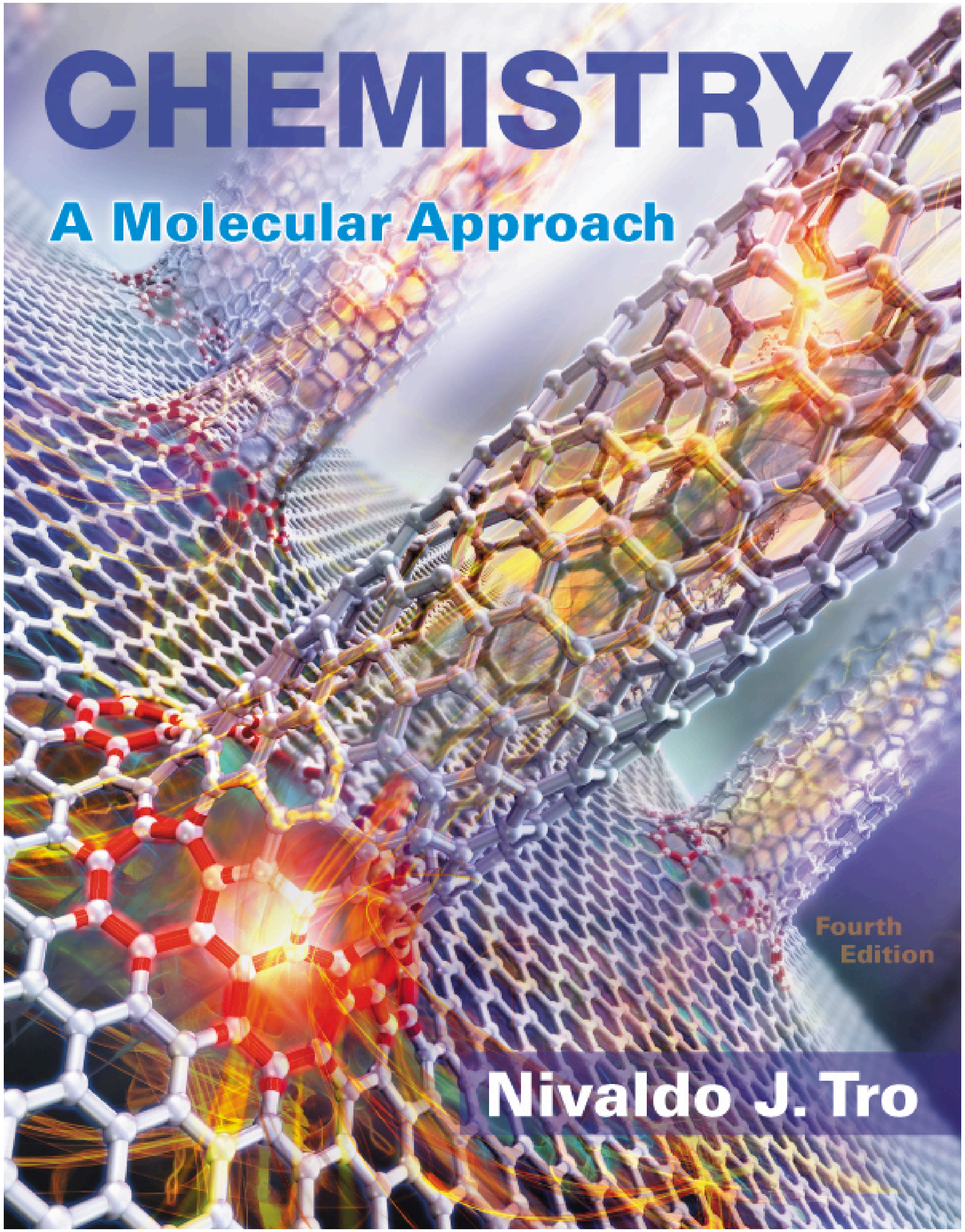


Lecture Presentation

Chapter 5

Gases

Ideal Gas Law $PV = nRT$

- By combining the gas laws, we can write a general equation.
- ***R*** is called the **gas constant.**
- The value of ***R*** depends on the units of *P* and *V*.
  - We will use $PV = nRT$ and convert *P* to atm and *V* to liters.
- The other gas laws are found in the ideal gas law if two variables are kept constant.
- The ideal gas law allows us to find one of the variables if we know the other three.

$$V = \frac{RnT}{P}$$

Ideal Gas Law $PV = nRT$

- P = pressure, in atmosphere (atm)

  760 mm Hg = 760 torr = 1 atm

- V= Volume, in Liters (L)

- n = moles

  moles = grams / formula mass

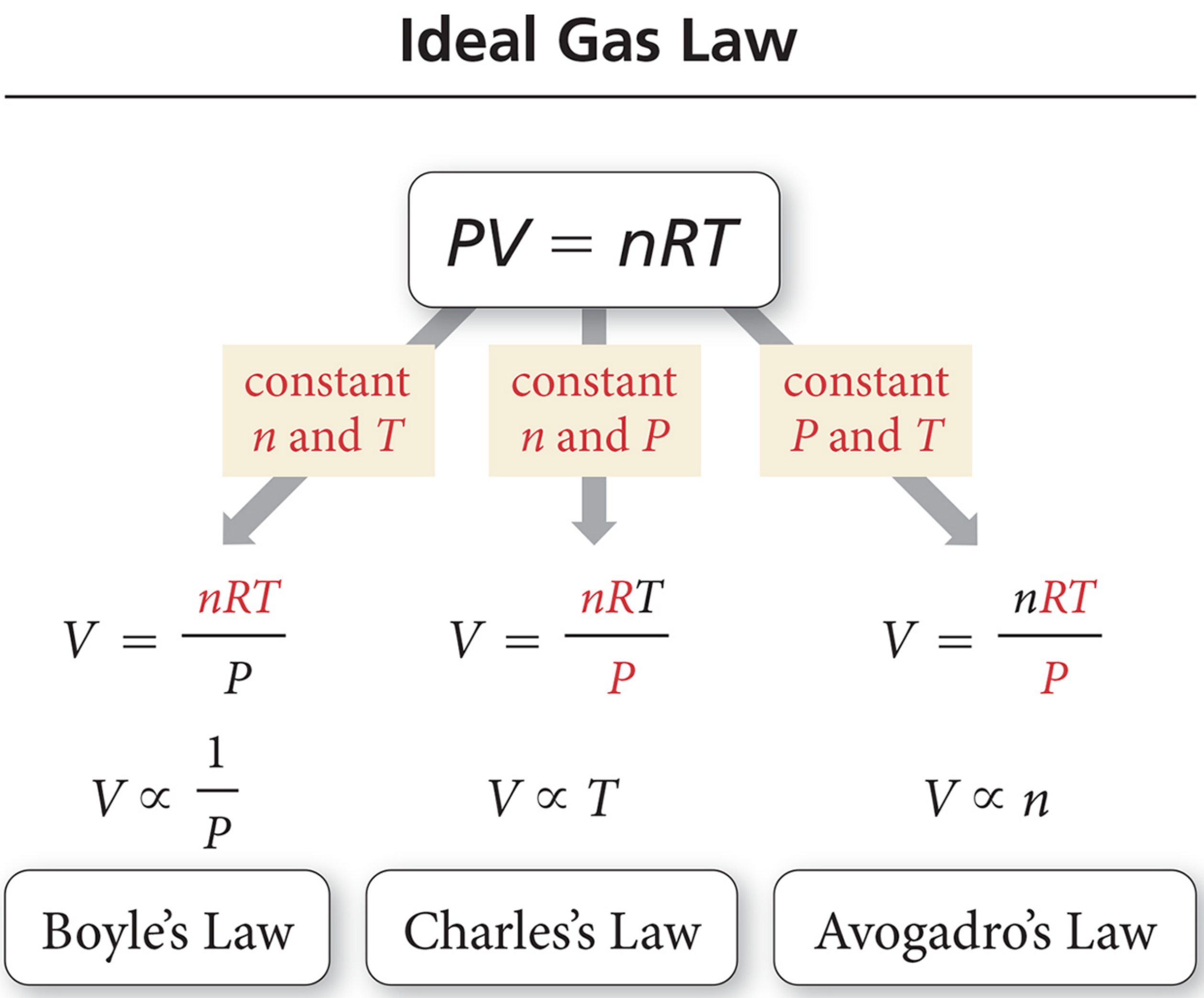
- R = ideal gas law constant, 0.08206 (L atm) / (mol K)

- T = temperature, Kelvin

  ^{o}C + 273.15 = Kelvin

Examples

Ideal Gas Law



- End 10/5/16 class

- Combined Gas Law can be derived from ideal gas law

$$P_2V_2 = n\,R\,T_2$$
$$P_1V_1 = n\,R\,T_1$$

Use to convert pressure, volume and temperature for the same gas under different conditions

$$\frac{P_2V_2}{P_1V_1} = \frac{T_2}{T_1}$$

Standard Conditions

- Because the volume of a gas varies with pressure and temperature, chemists have agreed on a set of conditions to report our measurements so that comparison is easy.
  - We call these **standard conditions**.
  - STP
- Standard pressure = 1 atm
- Standard temperature = 273 K = 0 °C

Molar Volume

- The volume occupied by one mole of a substance is its **molar volume** at STP (*T* =273 K or 0 °C and P = 1atm).

$$V = \frac{nRT}{P}$$

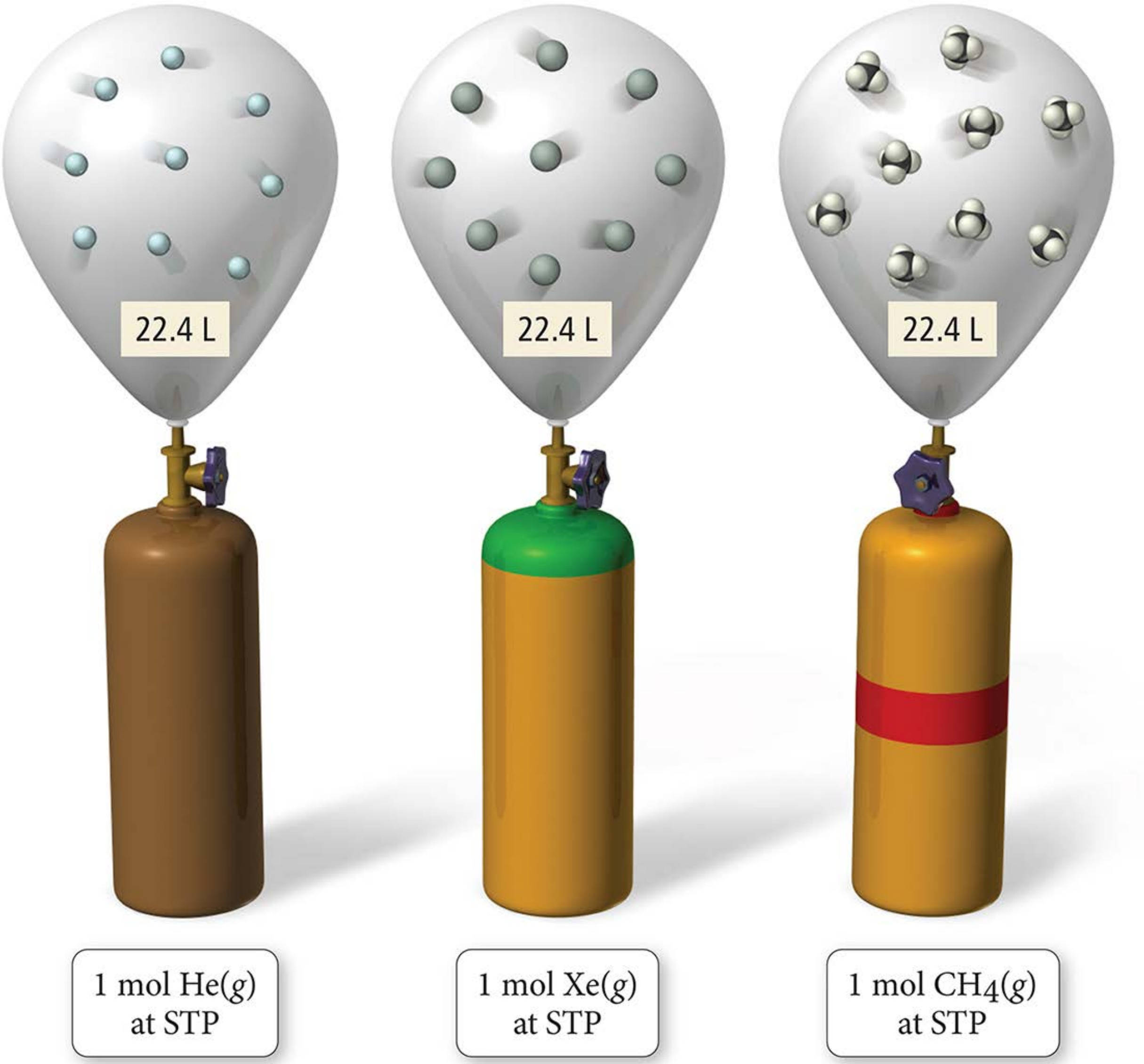
$$= \frac{1.00\ \cancel{\text{mol}} \times 0.08206\ \dfrac{\text{L}\cdot\cancel{\text{atm}}}{\cancel{\text{mol}}\cdot\cancel{\text{K}}} \times 273\ \cancel{\text{K}}}{1.00\ \cancel{\text{atm}}}$$

$$= 22.4\ \text{L}$$

Molar Volume at STP

- Solving the ideal gas equation for the volume of 1 mol of gas at STP gives 22.4 L.
  - 6.022×10^{23} molecules of gas
  - Notice that the gas is immaterial.
- We call the volume of 1 mole of gas at STP the **molar volume**.
  - It is important to recognize that one mole measurements of different gases have different masses, even though they have the same volume.

Molar Volume at STP



Mixtures of Gases

- Many gas samples are not pure but are mixtures of gases.
- Dry air, for example, is a mixture containing nitrogen, oxygen, argon, carbon dioxide, and a few other gases in trace amounts.

TABLE 5.3 Composition of Dry Air

Gas	Percent by Volume (%)
Nitrogen (N_2)	78
Oxygen (O_2)	21
Argon (Ar)	0.9
Carbon dioxide (CO_2)	0.04

Mixtures of Gases

- Therefore, in certain applications, the mixture can be thought of as one gas.
  - Even though air is a mixture, we can measure the pressure, volume, and temperature of air as if it were a pure substance.
  - We can calculate the total moles of molecules in an air sample, knowing P, V, and T, even though they are different molecules.

Partial Pressure

- The pressure of a single gas in a mixture of gases is called its **partial pressure**.
- We can calculate the partial pressure of a gas if
  - we know what fraction of the mixture it composes and the total pressure, or
  - we know the number of moles of the gas in a container of known volume and temperature.
- The sum of the partial pressures of all the gases in the mixture equals the total pressure:
  - Dalton's law of partial pressures
  - Gases behave independently.

$$P_{\text{total}} = P_{\text{a}} + P_{\text{b}} + P_{\text{c}} + \ \ldots$$

Dalton's Law of Partial Pressures

- For a multicomponent gas mixture, we calculate the partial pressure of each component from the ideal gas law and the number of moles of that component (n_n) as follows:

$$P_a = n_a \frac{RT}{V}; \quad P_b = n_b \frac{RT}{V}; \quad P_c = n_c \frac{RT}{V}; \ldots$$

- The sum of the partial pressures of the components in a gas mixture equals the total pressure:

$$P_{total} = P_a + P_b + P_c + \ \ldots$$

Examples

End Exam II