

Chapter 9 Part 2

Dr. Turner

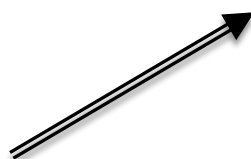
Ideal Gas Law

$$PV = nRT$$

$$\frac{PV}{nT} = R$$

$$\frac{PV}{nT} = 0.0821 \frac{\text{L atm}}{\text{mol K}}$$

This is true
regardless of
what P, V, n,
and T are



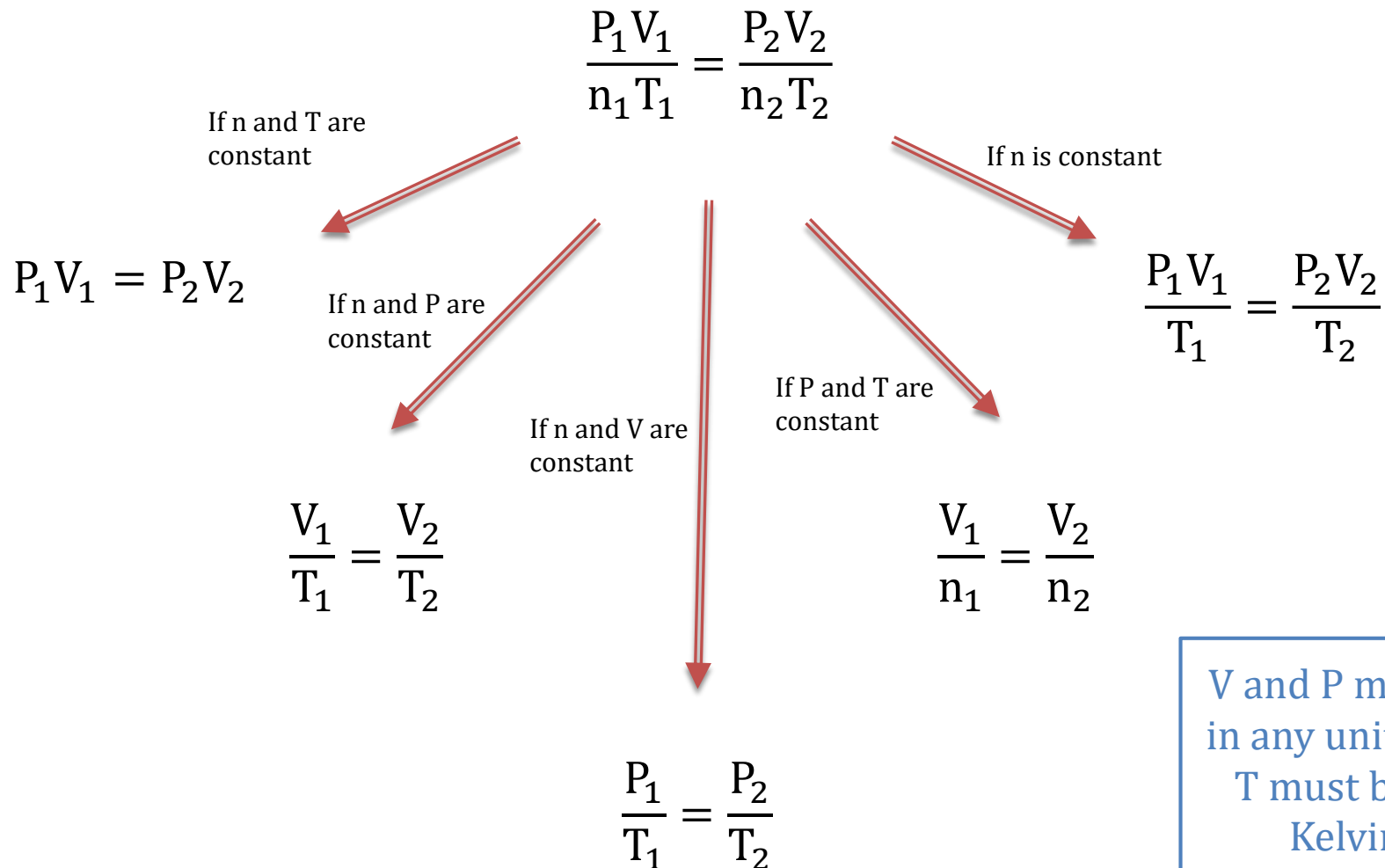
Ideal Gas Law

So if $\frac{P_1 V_1}{n_1 T_1} = 0.0821 \frac{\text{L atm}}{\text{mol K}}$ and $\frac{P_2 V_2}{n_2 T_2} = 0.0821 \frac{\text{L atm}}{\text{mol K}}$

then

$$\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$$

From this we see several relations



Gas Laws

A volume of air occupying 12.0 cm^3 at 98.9 kPa is compressed to a pressure of 119.0 kPa . The temperature remains constant. What is the new volume in cm^3 ?

Gas Laws

If 10.1 L of nitrogen gas at 23.00 °C has a pressure of 746 mmHg, what is the volume in L of nitrogen gas at 0.00 °C and 760 mmHg?

Gas Laws

A cylinder containing 44 L of helium gas at a pressure of 170. atm is to be used to fill toy balloons to a pressure of 1.1 atm. Each inflated balloon has a volume of 2.0 L. What is the maximum number of balloons that can be inflated?

Gas Laws

At a certain pressure and temperature, a gas occupies 20 L. If pressure and temperature are held constant, what will be the volume if half the gas sample escapes?

- A. 2 L
- B. 10 L
- C. 20 L
- D. 40 L

Standard Temperature and Pressure (STP)

- Under standard temperature and pressure
 - ▣ $P = 1.00 \text{ atm}$
 - ▣ $T = 273.15 \text{ K}$
- At STP, 1 mole has a volume of 22.4 L. This is called the standard molar volume.

Gas Laws

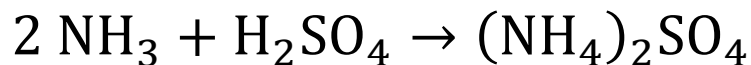
A sample of hydrogen occupies 375 mL at STP. If the temperature were increased to 819.00°C, what final pressure would be necessary to keep the volume constant at 375 mL?

Gas laws and stoichiometry

- Gas data may also be used for the purposes of stoichiometry
- Primarily, the ideal gas law will be used to find the amount of moles based on the pressure, volume, and temperature of the gas

Stoichiometry involving gases

Ammonium sulfate is used as nitrogen and sulfur fertilizer. It is produced by reacting ammonia with sulfuric acid. What volume (in liters) of ammonia at 288.15 K and 1.15 atm is required to produce 150.0 g of ammonium sulfate (132.14 g/mol)?



Stoichiometry involving gases

An air bag is inflated with nitrogen, N_2 , using the rapid reaction of sodium azide, NaN_3 , and iron(III) oxide, Fe_2O_3 , which is initiated by a spark. The overall reaction is



How many grams of sodium azide would be required to provide 75.0 L of nitrogen gas at 25.00 °C and 748 mmHg?

Dalton's Law of Partial Pressures

- States that the pressure of a gas mixture is equal to the sum of the partial pressures of the individual gases

$$P_{\text{total}} = P_A + P_B + P_C$$

- P_{total} is the total pressure in the system
- P_A , P_B , and P_C are the partial pressures of gases A, B, and C respectively

Partial pressures and mole fractions

- The degree to which any one gas contributes to the partial pressure is directly related to the amount of that gas present in the mixture

$$\chi_A P_{\text{total}} = P_A$$

- χ_A is the mole fraction of gas A
- P_A is the partial pressure of gas A
- P_{total} is the total pressure of the system

Partial pressures

A 1.00 L sample of dry air at 298.15 K and 1.03 atm contains 0.925 g N_2 , plus other gases including oxygen, argon, and carbon dioxide. (A) How many moles of air are in the sample? (B) What is the mole fraction of N_2 in the mixture? (C) What is the partial pressure (in atm) of N_2 in the air sample?

Partial pressures

A 200. mL flask contains 3.22×10^{-5} mol O_2 and 1.40×10^{-4} mol He at 15.00°C . (A) What is the total pressure? (B) What are the partial pressures of oxygen and helium in the flask?

Collecting gas over water

$$P_{\text{total}} = P_{\text{gas}} + P_{\text{water}}$$

- P_{total} is the total pressure
- P_{gas} is the partial pressure of the gas being collected
- P_{water} is the vapor pressure of water

Collecting gas over water

A sample of hydrogen gas (H_2) is collected over water. The 0.156 L of collected gas has a pressure of 769 mmHg at 292.15 K. If the vapor pressure of water at 292.15 K is 16.5 mmHg, (A) what is the partial pressure of the hydrogen gas in atm? (B) What is the mass (in g) of the collected hydrogen gas?