GASES

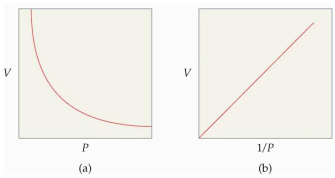
Characteristics of Gases

Pressure

Barometers and Atmospheric Pressure

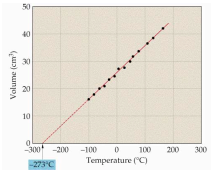
Gas Laws

Boyle's Law



Ex 1 Some nitrogen gas is in a 2.00-L tank at a pressure of 3.00 atm. The tank is connected to a 5.00-L tank that is completely empty (evacuated), and a valve connects the two tanks., If the valve is opened, determine the total pressure in this two-tank system after the nitrogen stops flowing. No temperature change occurs in the process.

Charles's Law



Avogadro's Law

Ex 2 A certain mass of C_3H_6 reacts completely with an excess of ammonia and oxygen to give 38.2 L of C_3H_3N at 75°C and P = 1.00 atm. If the same mass of C_3H_6 reacts completely at 350°C and P = 1 atm, what volume of C_3H_3N can be collected at the higher temperature?

$$2\ C_3H_{6(g)} + 2\ NH_{3(g)} + 3\ O_{2(g)} \rightarrow 2\ C_3H_3N_{(g)} + 6\ H_2O_{(g)}$$

The Ideal-Gas Equation

Ex 3 A gas is in a container with a movable piston under a pressure of 6.4 atm. The volume of the container is increased by a factor of 4.5 by moving the piston. The absolute temperature is simultaneously doubled. Calculate the pressure of the gas after these changes.

Ex 4 At what temperature (in K) does 29.8 g of O_2 gas have a pressure of 2.00 atm in a 10.0-liter tank?

Applications of the Ideal-Gas Equation

Gas Density and Molar Mass

Ex 5 Calculate the density of gaseous SF_6 at a temperature of 27°C and a pressure of 0.873 atm.

Ex 6 The empirical formula of a gaseous fluorocarbon is CF_2. If 1.55 g of this compound occupies 0.174 L at STP determine the molecular formula of this compound.

Ex 7 An important process for the production of acrylonitrile (C_3H_3N) is given by the reaction: $2\ C_3H_{6(g)} + 2\ NH_{3(g)} + 3\ O_{2(g)} \rightarrow 2\ C_3H_3N_{(g)} + 6\ H_2O_{(g)}$

A 150.0-L reactor is charged to the following partial pressures at 25°C:
$P_{C3H6} = 4.93$ atm, $P_{NH3} = 7.90$ atm, $P_{O2} = 14.8$ atm
What mass of acrylonitrile can be produced from this mixture?

Ex 8 A 0.326-g sample of XH_2 reacts with water according to the equation

$$XH_{2(s)} + 2\ H_2O_{(l)} \rightarrow X(OH)_{2(s)} + 2\ H_{2(g)}$$

The hydrogen evolved is found to have a volume when dry of 375 cm^3 at 21°C and 1.00 atm. What is the atomic mass of X?

Gas Mixtures and Partial Pressures

Partial Pressure

Mole Fraction

Ex 9 The partial pressure of $O_{2(g)}$ in a mixture of $O_{2(g)}$ and $H_{2(g)}$ is 2.54 atm. The total pressure of the mixture is 3.92 atm. Determine the partial pressure of H_2(g), and the mole fraction of each gas in the mixture.

Ex 10 A gas mixture at room temperature contains 4.3 mol of H_2 and 8.2 mol of N_2.
(a) Compute the mole fraction of N_2 in the mixture.

(b) The mixture is then heated, and the N_2 starts to react with the H_2 to give NH_3:

$$N_{2(g)} + 3\ H_{2\ (g)} \rightarrow 2\ NH_{3(g)}$$

The reaction is stopped when 2.8 mol of NH_3 is present. Determine the mole fraction of N_2 in this new mixture.

Collecting Gases over Water

Ex 11 Acetylene (C_2H_2) can be made by allowing calcium carbide to react with water.

$$CaC_{2\ (s)} + 2\ H_2O_{(l)} \rightarrow C_2H_{2(g)} + Ca(OH)_{2(aq)}$$

You place 2.65 g of CaC_2 in excess water and collect the acetylene over water.

(a) Calculate the theoretical yield of acetylene (in grams).

(b) After reaction, the volume of the acetylene and water vapor is 795 mL at 25.0°C and a pressure of 0.967 atm. Calculate the percent yield of acetylene. The vapor pressure of water at 25.0°C is 0.0313 atm.

Molecular Motion

The Kinetic Theory of Gases

Temperature and Molecular Motion

Distribution and Molecular Speeds

Mean Free Path and Diffusion

Gaseous Effusion

Ex 12 Methane (CH_4) effuses through a small opening at the rate of 1.30×10^{-8} mol/s. An unknown gas effuses through the same opening at the rate of 5.42×10^{-9} mol/s (at the same T & P as the methane). Determine the molar mass of the unknown gas.

Real Gases

Real gases obey the ideal gas law at low pressures only.

Van der Waals Equation of State

Ex 13 Oxygen is supplied to hospitals and chemical laboratories under pressure in large steel cylinders. Typically, such a cylinder has an internal volume of 28.0 L and contains 6.80 kg of oxygen. Use the van der Waals equation to estimate the pressure inside such a cylinder at 20°C.