

Chemistry II - Chapters on Gases - Practice Problems

Boyle's Law:

ex> Consider a 1.53 L sample of gaseous SO_2 (a gas that plays the central role in the formation of acid rain) at a pressure of 5.6×10^3 Pa. If the pressure is changed to 1.5×10^4 Pa at a constant temperature, what will the new volume of the gas be? [0.57 L]

Charles's Law:

ex> A sample of gas at 15°C and 1 atm had a volume of 2.58 L. What volume will this gas occupy at 38°C and 1 atm? [2.79 L]

Combined Gas Law:

ex> A sample of diborane gas (B_2H_6), a substance that bursts into flame when exposed to air, has a pressure of 345 torr at a temperature of -15°C and a volume of 3.48 L. If conditions are changed so that the temperature is 36°C and the pressure is 468 torr, what will the volume of the sample be? [3.07 L]

Avogadro's Law:

ex> Suppose we have a 12.2 L sample containing 0.50 mol of oxygen gas (O_2) at a pressure of 1 atm and a temperature of 25°C . If all this O_2 were converted to ozone (O_3) at the same temperature and pressure, what would the volume of the ozone be? [8.1 L]

Ideal Gas Law:

ex> A sample of hydrogen gas (H_2) has a volume of 8.56 L at a temperature of 0°C and a pressure of 1.5 atm. Calculate the number of moles of hydrogen molecules present. [0.57 mol]

ex2> A sample containing 0.35 moles of argon gas at a temperature of 13 °C and a pressure of 568 torr was heated to 56 °C with a pressure of 897 torr. Calculate the change in volume. [-3 L]

Gas Stoichiometry:

ex> A sample of nitrogen gas has a volume of 1.75 L at STP. How many moles of N₂ are present?
[7.81 x 10⁻² moles]

ex> Quicklime (CaO) is produced by the thermal decomposition of calcium carbonate (CaCO₃). Calculate the volume of carbon dioxide at STP produced from the decomposition of 152 g of calcium carbonate.
[34.1 L]

ex> A sample of methane gas having a volume of 2.80 L at 25 °C and 1.65 atm was mixed with a sample of oxygen gas with a volume of 35.0 L at 31 °C and 1.25 atm. The mixture was then ignited. Calculate the volume of carbon dioxide formed at a pressure of 2.50 atm and a temperature of 125 °C.
[2.47 L]

Molar Mass from Vapor Density (like our lab):

ex> The density of a gas was measured at 1.50 atm and 27 °C and found to be 1.95 g/L. Calculate the molar mass of the gas.
[32.0 g/L]

Gas Law Problems

- 1) A particular balloon is designed by its manufacturer to be inflated to a volume of no more than 2.5 L. If the balloon is filled with 2.0 L of helium at sea level, is released, and rises to an altitude at which the atmospheric pressure is only 500. mm Hg, will the balloon burst? (Assume temperature is constant.)
- 2) An 11.2 L sample of gas is determined to contain 0.50 mol of N_2 . At the same temperature and pressure, how many moles of gas would there be in a 20.-L sample? [0.89 mol]
- 3) Complete the following table for an ideal gas:

P (atm)	V (L)	n (mol)	T
5.00		2.00	155 °C
0.300	2.00		155 K
4.47	25.0	2.01	
	2.25	10.5	75 °C

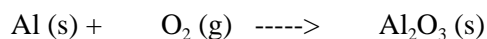
- 4) Suppose two 200.0-L tanks are to be filled separately with the gases helium and hydrogen. What mass of each gas is needed to produce a pressure of 135 atm in its respective tank at 24 °C?
[4.44×10^3 g He and 2.24×10^3 g H_2]
- 5) A 2.50-L contained is filled with 175 g argon.
 - (a) If the pressure is 10.0 atm, what is its temperature? [69.6 K]
 - (b) If the temperature is 225 K, what is the pressure? [32.3 atm]
- 6) A gas sample containing 1.50 mol at 25 °C exerts a pressure of 400. torr. Some gas is added to the same container, and the temperature is increased to 50. °C. If the pressure increases to 800. torr, how many moles of gas were added to the container? Assume a constant-volume container. [1.27 mol]
- 7) An ideal gas is contained in a cylinder with a volume of 5.0×10^2 mL at a temperature of 30. °C and a pressure of 710. torr. The gas is then compressed to a volume of 25 mL, and the temperature is raised to 820. °C. What is the new pressure of the gas? [5.1×10^4 torr]
- 8) A sealed balloon is filled with 1.00 L of helium at 23 °C and 1.00 atm. The balloon rises to a point in the atmosphere where the pressure is 220. torr and the temperature is -31 °C. What is the change in volume of the balloon as it ascends from 1.00 atm to a pressure of 220. torr? [changed 1.82 L]

Additional book practice:

p. 472-474 #32 [423 L], 33 [669 L], 34 [160 kPa], 40 [a. 3.29 mL, b. 2.20 m³, c. 761 mL, d. 4.44 L], 41, 42 [313 °C], 43, 44 [379 mL], 45, 46, 47, 58, 61, 62 [291 kPa], 63 [359 °C], 64, 68, 69, 77, 78, 79, 81, 82, 83

Gas Density, Molar Mass, and Gas Reaction Stoichiometry

- 9) Consider the following reaction:



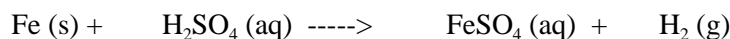
It takes 2.00 L of pure oxygen gas at STP to react completely with a certain sample of aluminum. What is the mass of the aluminum reacted? [3.21 g Al]

- 10) Air bags are activated when a severe impact causes a steel ball to compress a spring and electrically ignite a detonator cap. This causes sodium azide (NaN_3) to decompose explosively according to the following reaction:



What mass of sodium azide must be reacted to inflate an air bag to 70.0 L at STP? [135 g]

- 11) In 1897, the Swedish explorer Andreé tried to reach the North Pole in a balloon. The balloon was filled with hydrogen gas. The hydrogen gas was prepared from iron splints and diluted sulfuric acid. The reaction is



The volume of the balloon was 4800 m^3 , and the loss of hydrogen gas during filling was estimated at 20%. What mass of iron splints and 98% (by mass) H_2SO_4 were needed to ensure the complete filling of the balloon? Assume a temperature of 0°C , a pressure of 1.0 atm during filling, and 100% yield. [$1.5 \times 10^7 \text{ g Fe}$, $2.6 \times 10^7 \text{ g 98\% H}_2\text{SO}_4$]

- 12) Consider the combustion reaction between 50.0 mL of liquid methyl alcohol (density 0.850 g/mL) and 22.8 L of O_2 at 27°C and a pressure of 2.00 atm. Calculate the number of moles of water formed if the reaction goes to completion. [2.47 mol water]

- 13) Hydrogen cyanide is prepared commercially by the reaction of methane, ammonia [$\text{NH}_3(\text{g})$], and oxygen at high temperature. The other product is gaseous water.

(a) Write the chemical equation for the reaction.

(b) What volume of hydrogen cyanide gas can be obtained from 20.0 L of methane, 20.0 L of ammonia, and 20.0 L of oxygen gas? The volumes of all gases are measured at the same temperature and pressure. [13.3 L]

- 14) An unknown diatomic gas has a density of 3.164 g/L at STP. What is the identity of the gas?

- 15) A compound has the empirical formula CHCl . A 256-mL flask, at 373 K and 750. torr, contains 0.800 g of the gaseous compound. Give the molecular formula.

- 16) Uranium hexafluoride is a solid at room temperature, but it boils at 56°C . Determine the density of uranium hexafluoride at 60°C and 745 torr. [12.6 g/L]

Additional book practice:

p. 494-496 #34, 35, 36 [b. 0.0188 mol], 37 [a. 67.2 L, b. 0.122 L, c. 11.1 L], 38, 39 [99.7 kPa], 40, 41 [64.8 L], 42, 43 [39.6 g/mol], 44, 46 [6.59 L], 47, 48 [a. 3.54 L], 49, 50, 51 [8.89 g], 52, 53 [b. 833 mL SO_2], 54, 55 [a. 3.73 L H_2], 56, 58 [0.289 L], 59, 60, 63, 64, 66, 67 [12.7 L O_2], 69