Chem Unit 11 Gases
Boyle's Law

Boyle's Law: Pressure and Volume relationships in gases

Review:

- Pressure is due to collisions of particles with the walls of a container.
- Units include: 760 mmHg = 760 torr = 1 atm = 14.7 psi = 101,325 Pa = 101.3 kPa

Boyle's Law:

- Robert Boyle first studied the relationship between P & V in gases.
- He found that P & V are inversely related! ($\uparrow P = \downarrow V$)
- Wrote the relationship mathematically as ...

  $P_1V_1 = P_2V_2$ (1 = initial conditions; 2 = new conditions)
- This is called Boyle's Law!

Examples:

(1) 5 L of a gas at 2 atm P will have what volume at 5 atm?

$V_1 = 5L \quad P_1 = 2atm \quad V_2 = ? \quad P_2 = 5atm$

$V_1P_1 = V_2P_2 \qquad \frac{V_1P_1}{P_2} = V_2$

$\frac{5L \mid 2atm}{5atm} = \boxed{2L}$

(2) 325 mL of a gas at 730. torr will have what volume at 15.09 psi?

$V_1 = 325mL \quad P_1 = 730.torr \quad V_2 = ? \quad P_2 = 15.09psi$

$V_2 = \frac{V_1P_1}{P_2}$

$\frac{325mL \mid 730.torr \mid 14.7psi}{15.09psi \mid 760torr} = 304.1030135\ mL$ $\boxed{304\ mL}$

Cautions:

1. Always watch your units ... use the same volume and pressure on both sides.
2. Use common sense ... think about your answer!

Assignment:

1. Read 13.1-13.2 (pp. 399-407)
2. Work problems on p. 436: 7, 8, 10

Additional Problems:

1. Synthetic diamonds can be manufactured at pressures of 6.00×10^4 atm. If a chemist took 2.00 L of gas at 1.00 atm and compressed it to a pressure of 6.00×10^4 atm, what would the volume of that gas be?

$V_1 = 2.00\ L$ $P_1 = 1.00\ atm$ $\frac{P_1 V_1}{P_2} = V_2$ $V_2 = ?$ $P_2 = 6.00 \times 10^4\ atm$

$\frac{1.00\ atm \mid 2.00\ L}{6.00 \times 10^4\ atm} = .0000333333$

$.0000333\ L$ $3.33 \times 10^{-5}\ L$

2. Atmospheric pressure on the peak of Mt. Everest can be as low as 150. mmHg, which is why climbers need to bring oxygen tanks for the last part of the climb. If the climbers carry 10.0 L tanks with an internal gas pressure of 3.04×10^4 mmHg, what will be the volume of the gas when it is released from the tanks? $V_1 = 10.0\ L$ $P_1 = 3.04 \times 10^4\ mmHg$ $P_2 = 150.\ mmHg$ $V_2 = ?$

$\frac{P_1 V_1}{P_2} = V_2$

$\frac{10.0\ L \mid 3.04 \times 10^4\ mmHg}{150.\ mmHg} = 2026.6666$

$2030\ L$

3. An experimental research submarine with a volume of 15,000 L has an internal pressure of 1.2 atm. If the submarine ruptures while underwater at a pressure of 250 atm and the gas is released, how large a bubble will form?

$V_2 = \frac{P_1 V_1}{P_2}$ $V_1 = 15{,}000\ L$ $P_1 = 1.2\ atm$ $P_2 = 250\ atm$ $V_2 = ?$

$\frac{1.2\ atm \mid 15{,}000\ L}{250\ atm} = 72\ L$

4. In a thermonuclear device, the pressure of 0.50 L of gas within the bomb casing reaches 4.0×10^6 atm. When the bomb casing is destroyed by the explosion, the gas is released into the atmosphere where it reaches a pressure of 1.00 atm. What is the volume of the gas after the explosion?

$V_1 = .50\ L$ $P_1 = 4.0 \times 10^6\ atm$ $P_2 = 1.00\ atm$ $V_2 = ?$

$V_2 = \frac{V_1 P_1}{P_2}$

$\frac{.50\ L \mid 4.0 \times 10^6\ atm}{1.00\ atm} = 2.0 \times 10^6\ L$