Success 24/7 Chemistry: Gas Law Formulas

Variables to know for this unit:

P = pressure (atm)

V = volume (L)

T = temperature (K only)

n = number of moles (mol)

R = ideal gas constant (0.0821 $\frac{L \bullet atm}{mol \bullet K}$)

To convert ^{o}C to K:

K = 273 + ^{o}C

Boyle's Law

$P_1V_1 = P_2V_2$

Pressure and volume are indirectly related if temperature is held constant.

Memory tool: "**Boyle**" your **P**eas and **V**eggies

Practice

1. A gas occupies 12.3 liters at a pressure of 40.0 mm Hg. What is the volume when the pressure is increased to 60.0 mm Hg?

2. If a gas at 25.0 °C occupies 3.60 liters at a pressure of 1.00 atm, what will be its volume at a pressure of 2.50 atm?

NOTE: Temperature MUST be in Kelvin!

K = 273 + ^oC

Charles's Law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Volume and temperature are directly related when pressure is held constant.

Memory Trick: **Charl**ie Brown Christmas is on **TV**.

Practice:

1. Calculate the decrease in temperature when 2.00 L at 20.0 °C is compressed to 1.00 L.

2. 600.0 mL of air is at 20.0 °C. What is the volume at 60.0 °C?

Gay-Lussac's Law

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

NOTE: Temperature MUST be in Kelvin!

K = 273 + ^oC

Pressure and temperature are directly related when volume is held constant.

Memory Trick: "**Gayle**" drives a **PT** Cruiser

Practice:

1. Determine the pressure change when a constant volume of gas at 1.00 atm is heated from 20.0 °C to 30.0 °C.

2. A gas has a pressure of 0.370 atm at 50.0 °C. What is the pressure at standard temperature?

Combined Gas Law

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

NOTE: Temperature MUST be in Kelvin!

$K = 273 + {}^{o}C$

Memory Trick:

Peas and **V**eggies sit on the **T**able!

Practice:

1. A gas sample occupies 3.25 liters at 24.5 °C and 1825 mm Hg. Determine the temperature at which the gas will occupy 4250 mL at 1.50 atm.

2. If 10.0 liters of oxygen at STP are heated to 512 °C, what will be the new volume of gas if the pressure is also increased to 1520.0 mm of mercury?

Ideal Gas vs. Real Gas

Ideal gases follow the gas laws at all conditions of temperature and pressure.

Real gases can be liquefied and sometimes solidified.

Ideal gases do NOT exist, but scientists utilize the thought of them to find a foundation to build on and add in "real world" factors. (We will not do this in our course.)

Ideal Gas Law

PV = nRT

Units are extremely important for this equation and MUST be as follows due to "R"!

P = pressure (atm)

V = volume (L)

T = temperature (K only)

n = number of moles (mol)

R = ideal gas constant (0.0821 $\frac{L \bullet atm}{mol \bullet K}$)

Practice:

1. What volume is occupied by 5.03 g of O_2 at 28°C and a pressure of 0.998 atm?

2. A sample of argon gas at STP occupies 56.2 liters. Determine the number of moles of argon and the mass in the sample.

Dalton's Law of Partial Pressures

At constant volume and temperature, the total pressure exerted by a mixture of gases is equal to the sum of the partial pressures.

$$P_{total} = P_1 + P_2 + P_3 \ldots$$

Practice:

1. A canister contains 425 kPa of carbon dioxide, 750 kPa of nitrogen, and 525 kPa of oxygen. What is the total pressure of the container?

2. A tank containing ammonia and argon has a total pressure equal to 1.8 atm. The pressure of the ammonia is 1.2 atm. What is the pressure of the argon gas?

Water Displacement Method of Capturing Gases

Many times, gases are collected over water. The following formula must be used because the water vapor pressure must be removed from the overall reading.

$$P_{gas} = P_{atmosphere} - P_{water}$$

A 250.mL sample of oxygen is collected over water at 25°C and 760.0 torr pressure. What is the pressure of the dry gas alone? (Vapor pressure of water at 25°C = 17.5 torr)