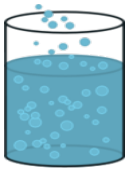
Gases and Gas Laws **Name**_____

The Ideal Gas Law

Read from **Lesson 2e: The Ideal Gas Law** in the **Chemistry Tutorial Section, Chapter 10** of **The Physics Classroom**:



The Combined Gas Law allows chemistry students to solve problems with three variables: pressure, volume, and temperature, if the amount of gas is constant. To work with all variables, we need another gas law. **The ideal gas law** was derived by physicist and engineer Benoît Paul Émile Clapeyron.

$$PV=nRT$$

where **P** is pressure in atm, kPa, torr, or mm Hg (we will address these units again!)
V is volume in L, **n** is number of moles of gas, **T** is temperature in K, and **R** is a proportionality constant. The value of R depends on which pressure unit is used in the equation.

R = 0.08206 L•*atm*/mol/K **R = 62.36 L•*torr*/mol/K** **R = 8.314 L • *kPa* /mol/K**

Some other considerations before solving ideal gas problems,

- the volume for a mole of any gas at STP is 22.4 L
- density is always mass/volume, but we can rewrite the ideal gas equation to find that density, **ρ** is

$$\rho = \frac{P \cdot MM}{R \cdot T}$$

MM is the molar mass of the gas.

Ideal Gas Law Problems Show all work as you solve these problems.

Example: A sample of gas has a volume of 165 mL and a pressure of 2.25 atm. If the temperature is 25°C, how many moles of gas are in the sample?

First, assign values to the variables in the equation
P = 2.25 atm
V = 165 mL = 0.165 L
n = ?
T =25°C + 273.15 = 298.15 K
R = 0.08206 L•*atm*/mol/K since P is in atm.

PV = nRT
(2.25)(0.165) = n* (0.08206)(298.15)
n = 0.0152 mol

1. Saucy Sally is making mac and cheese in her Instant Pot. The volume of the pot is 2.00 L and the pressure inside of the pot will reach a pressure of 152 kPa and a temperature of 100.0°C. How many moles of gas are contained in the Instant Pot?
   P =
   V =
   n =
   T =
   R =

2. Aaron Agin and Molly Cule are discussing gas density at STP while working in the chem lab. They are working with three gases: carbon dioxide, nitrogen trioxide, and iodine gas. Aaron states that all gases have the same density at STP because they all have the same volume. Molly disagrees. Who is correct? Which gas is the most dense at STP? Explain your reasoning.

Gases and Gas Laws

3. A typical full scuba tank used for recreational diving has a volume of 11.0 L and an internal pressure of 200 atm. What is the mass of oxygen in the tank, assuming all gas inside is O_2 and the temperature of the tank is 20.0°C?

4. Two 1-L flasks are sitting on a lab station in a room that is 25°C. One flask contains O_2 gas, and the other flask contains SO_2 gas. If flask #1 has an internal pressure of ***X*** atm and a mass of 3.2 g and flask #2 has an internal pressure of **2*X*** atm and a mass of 3.2 g. Which flask contains the O_2?

5. What is the density of carbon tetrachloride gas at 96.3 kPa and 200°C?

6. A fuel tank will rupture if the internal pressure reaches 27.8 atm. The tank contains 1401g of CO_2 at a pressure of 5.01 atm and a temperature of 25°C.
   a. What is the number of moles of CO_2 in the tank?

   b. What is the volume of the tank?

   c. To what temperature can the tank be heated before it ruptures? Report your answer in both K and °C.