The Ideal Gas Law Notes: Describing Gases Under Any Conditions

We've seen how the pressure, volume, and temperature of a gas are related to each other. The one thing we haven't considered is how the number of moles of a gas fit in with all these.

Increasing the molecules of a gas will:

a. increase the pressure (if V and T stay the same)
b. increase the volume (if P and T stay the same)

So how can we put together an equation that brings all these factors together? How can they relate? It turns out that the combined gas law is the key:

$$\frac{PV}{T} = \text{some constant times the number of moles}$$

Gas law types chose a new letter, n to represent the <u>n</u>umber of moles. So

$$\frac{PV}{T} = \text{constant} \cdot n$$

What's the constant? To figure that out, we'll use some data that we already know. We know that at STP, one mole of any gas occupies 22.4 L. So at STP and one mole of a gas,

T = 0ºC + 273 = 273K
P = 1.00 atm
V = 22.4 L
And n = 1.00 mole

Let's plug in these numbers and see what the constant is. First to do some rearranging…

$$\frac{PV}{T} = \text{constant} \cdot n$$

$$\frac{PV}{nT} = \text{constant}$$

Plug in the values to find the constant:

$$\frac{1.00\text{ atm} \cdot 22.4\text{ L}}{1.00\text{ mole} \cdot 273\text{ K}} = .0821\text{ L}\cdot\text{atm/mole}\cdot\text{K}$$ (I don't know why, but we seem to always say L before the atm. It doesn't really matter.)

The constant .0821 L•atm/mole•K is known as R, the Universal Gas Constant, and it ties P,V, T, and n together into one famous equation:

$$\frac{PV}{nT} = R$$

Better known as **PV = nRT** (pivnert)

Note: PV = nRT only works with liters, atmospheres, moles, and Kelvin because that's what R is based on. Here are some sample equations:

1) If you had 3.00 moles of H_2 gas , how big a balloon could you make at 1.01 atm and 23ºC? A: V = 72.2 L

2) A typical size 5 regulation soccer ball has a volume of 6.04 L and is supposed to be inflated to around 1.02 atm. How many moles of pure helium would you need to fill such a ball if you wanted to play with it at 25ºC (about 77ºF)? A: n = .252 moles He

3) What if the numbers given aren't all in liters, atmospheres, moles, or K? You'll have to convert.

Ex: What will be the volume of 40.5 grams of O_2 gas at 15ºC, and 13.5 psi?

A: V = 32.7L