Gas Laws II

Name____________________________ Lab Section #______

1. Distinguish between the gas, liquid and solid phase by listing the unique properties of each that are not shared by the others.

Gas: **Gases are fluids with no definite shape and no definite volume. Gases can expand and contract to fill a container. Gases have very low densities.**
Liquid: **Liquids are fluids which have a definite volume. Like gases, liquids have no definite shape. However, liquids will only fill the volume of a container to an extent to which it equals its own volume. Liquids are only slightly compressible.**
Solid: **Solids have a definite shape and a definite volume. Solids are not compressible. Solids are not fluids and, unless they are divided into very small particles, will not flow with the characteristics of a liquid or dense gas.**

2. When an aerosol can is full at 25 ˚C, the internal pressure is 2.50 atm. What is the new internal pressure at 1000˚C?

$P_1V_1 = n_2RT_2$	$P_2V_2 = n_2RT_2$
$P_1 = 2.50$ atm	$P_2 = x$
$V_1 = ?$	$V_2 = V_1$
$n_1 = ?$	$n_2 = n_1$
$T_1 = 298$K	$T_2 = 1273$ K

$$\frac{P_1}{T_1} = \frac{n_1R}{V_1} \text{ and } \frac{n_2R}{V_2} = \frac{P_2}{T_2}$$

$$\frac{n_1R}{V_1} = \frac{n_2R}{V_2} \text{ is a constant, therefore, } \frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{2.50 \text{ atm}}{298 \text{ K}} (1273 \text{ K}) = P_2 = 10.7 \text{ atm}$$

3. If 1.00 moles of an ideal gas at 1.00 atm and 273 K (STP) occupies a volume of 22.4 L, calculate the value and determine the units for R.

$$\mathbf{PV = nRT}$$

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

n = 1.00 mol: T = 273 K: V = 22.4 L: P 1.00 atm

Substituting;

$$\mathbf{R = \frac{1.00\ atm \cdot 22.4\ L}{1.00\ mol \cdot 273\ K}}$$

$$\mathbf{R = 0.0821\ \frac{L{\cdot}atm}{mol{\cdot}K}}$$

4. What pressure is required to confine 0.460 mol of an ideal gas at 33.0 ˚C in a volume of 9.50 L?

Using the equation PV = nRT, assign the known and unknown variables. Typically, for single value problems this is easy. In this case;

$$\mathbf{P = \frac{nRT}{V}}$$

n = 0.460 mol: T = 33 + 273 = 306 K: V = 9.50 L: P is unknown.

Substituting;

$$\mathbf{P(9.50\ L) = 0.460\ mol\ (0.0821\ \frac{L{\cdot}atm}{mol{\cdot}K})(306\ K)}$$

$$\mathbf{P = \frac{0.460\ mol\ (0.0821\ \frac{L{\cdot}atm}{mol{\cdot}K})(306\ K)}{9.50\ L} = 1.22\ atm}$$

5. What is the volume of a bulb that contains 3.56 g of nitrogen gas at 25.0 ˚C and 3.50 atm?

Using the equation PV = nRT, assign the known and unknown variables. Typically, for single value problems this is easy. In this case;

$$\mathbf{V = \frac{nRT}{P}}$$

T = 25 + 273 = 298 K: V = is unknown: P = 3.50 atm: n = must be calculated.

$$\mathbf{n = 3.56\ g\ N_2\left(\frac{1\ mol}{28.0\ g}\right) = 0.127\ mol\ N_2}$$

$$\mathbf{(3.50\ atm)V = 0.127\ mol\ \left(0.0821\ \frac{L{\cdot}atm}{mol{\cdot}K}\right)(298\ K)}$$

$$\mathbf{V = \frac{0.127\ mol\ \left(0.0821\ \frac{L{\cdot}atm}{mol{\cdot}K}\right)(298\ K)}{3.50\ atm} = 0.888\ L}$$

6. Calculate the density of oxygen gas at 1.00 atmosphere and 0.00 ˚C.

To solve this problem, we must begin with the ideal gas equation again and assign the known and unknown variables.

T = 0 ˚C + 273 = 273: P = 1 atm: V is unknown: n is unknown

It appears this problem cannot be solved as we have solved the others. By manipulating the ideal gas equation it is possible to find an answer.

$$\mathbf{PV = nRT \qquad n = \frac{mass\ (m)}{MW\ (molar\ mass)}}$$

$$\mathbf{PV = \frac{m}{MW}\ RT}$$

$$\mathbf{P(MW) = \frac{mRT}{V}}$$

$$\mathbf{P(MW) = \frac{m}{V} \cdot RT \qquad\qquad recall\ density = \frac{m}{V}}$$

$$\mathbf{P(MW) = density \cdot RT}$$

$$\mathbf{density = \frac{P(MW)}{RT}}$$

Now we can solve for the density of the gas.

$$\mathbf{density = \frac{1\ atm\left(32.0\ \frac{g}{mol}\right)}{0.0821\ \frac{L{\cdot}atm}{mol{\cdot}K}(273\ K)} = 1.43\ \frac{g}{L}}$$

This form of the ideal gas law is very useful for determining the molar mass of a gas, knowing the volume of a given amount (in grams) of gas at a particular pressure and temperature.