Chemistry Boot Camp
Summer 2013
VandenBout/LaBrake
Active Learning Session 1

Name: KEY

1. The ideal gas law can be represented using the following equation:

$$PV = nRT$$

a. What do the following symbols in the formula represent?

P Pressure

V Volume

n # moles of gas

R gas constant

T Temperature

Most gases including He and N_2 obey the ideal gas law at room temperature and pressure.

b. Recognizing that this is an equation, what do you predict would happen if you hold the values of V, n and R constant and change the value of T?

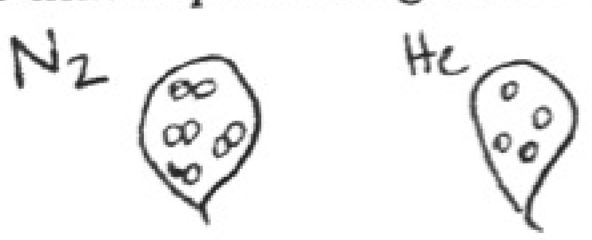
$PV = nRT$ If n, V, R are constant, P and T are directly related

If T↑, P↑ and if T↓, P↓

2. Note the two balloons in the front of the room. One contains He and the other contains N_2. For this argument we will assume the volume of the two balloons is exactly the same.

a. Describe the two balloons in terms of density. He balloon is less dense than Ne balloon since He balloon floats in air.

b. Draw a picture that depicts the gases in the two balloons.



c. Which of the two balloons contains more gas particles? Or do they contain the same number of gas particles. Please explain.

Since all conditions are the same (same P, T, V and R), the # of gas moles (n) must be equal. The balloons should contain the same # of gas particles.

$$n = \frac{PV}{RT}$$

An important concept for understanding the behavior of ideal gases is the number density, which is defined as the number of gas particles in units of moles per unit volume.

3. Express the ideal gas law in terms of number density.

$$\frac{PV}{V(RT)} = \frac{nRT}{V(RT)} \qquad \frac{n}{V} = \frac{P}{RT}$$

4. Given the pressure in this room is one atmosphere, the temperature is 298 K and the value for the ideal gas constant, R is 0.08206 L atm/mole K, calculate the number density for He and N_2.

$$\frac{n}{V} = \frac{1\text{ atm}}{\left(0.08206\ \frac{\text{L atm}}{\text{K mol}}\right)(298\text{ K})} = \frac{0.041\text{ mol}}{\text{L}}$$

The number density is the same for N_2 and He.

5. Typically density is interpreted as mass density. Which balloon has a higher mass density? Please explain.

N_2 balloon has a higher mass density because N_2 molecules have a greater mass than He atoms. (28 g mol^{-1} vs 4 g mol^{-1})

6. Calculate the mass density of the He balloon.

$$\frac{0.041\text{ mol}}{\text{L}} \times \frac{4\text{ g He}}{1\text{ mol He}} = \frac{0.16\text{ g}}{\text{L}} = \rho_{He} \text{ (mass density)}$$

7. Derive a formula for calculating the mass density for any ideal gas.

Multiplying number density by molar mass will always yield mass density for a gas.

$$MM\left(\frac{n}{V}\right) = \frac{P}{RT} \cdot MM$$

$$\rho = \frac{P \cdot MM}{RT}$$