AP CHEMISTRY

TOPIC 3: GASES, PART C EXAMPLE PROBLEMS Day 38:

- Dalton's Law of Partial Pressures
- Gas collection over Water

$$P_{Total} = P_A + P_B + P_C + \ldots = \frac{n_A RT}{V} + \frac{n_B RT}{V} + \frac{n_C RT}{V} + \ldots = (n_A + n_B + n_C + \ldots)\left(\frac{RT}{V}\right) = n_{Total}\left(\frac{RT}{V}\right)$$

(1)

1) Mixtures of helium and oxygen can be used in scuba diving tanks to help prevent "the bends." For a particular dive, 33 liters of helium at 20.0 °C and at 1.0 atm and 14 liters of oxygen at 20.0 °C and at 1.0 atm were pumped into a tank with a volume of 4.5 liters. Calculate the partial pressure of each gas and the total pressure in the tank at 20.0 °C.

FIRST, FIND TOTAL # OF MOLES OF GAS: $PV=nRT$

$$n_{He} = \frac{PV}{RT} = \frac{(1.0\ \text{ATM})(33\text{L})(\text{mol}\cdot\text{K})}{(0.0821\ \text{ATM}\cdot\text{L})(293\text{K})} = 1.3718\ \text{mol}$$

$$n_{O_2} = \frac{PV}{RT} = \frac{(1.0\ \text{ATM})(14\text{L})(\text{mol}\cdot\text{K})}{(0.0821\ \text{ATM}\cdot\text{L})(293\text{K})} = 0.58199\ \text{mol}$$

TOTAL = 1.9538 mol GAS

(2) NEXT, CALCULATE TOTAL PRESSURE IN "TANK"

$$P_T = \frac{nRT}{V} = \frac{(1.9538\ \text{mol})(0.0821\ \text{ATM}\cdot\text{L})(293\text{K})}{(4.5\text{L})\quad(\text{mol}\cdot\text{K})} = 10.444\ \text{ATM} \Uparrow P_T$$

(3) DETERMINE PARTIAL PRESSURES

$$P_{He} = \left(\frac{1.3718}{1.9538}\right)10.444\ \text{ATM} = 7.33\ \text{ATM}$$

$$P_{O_2} = \left(\frac{0.58199}{1.9538}\right)10.444\ \text{ATM} = 3.11\ \text{ATM}$$

2) Mole fraction: the ratio of the number of moles of a given component in a mixture to the total number of moles in the mixture.

$$P_A = P_{total} \times x_A, \quad where\ x_A = \frac{moles\ \ A}{total\ \ moles}$$

The partial pressure of oxygen gas was observed to be 160. torr in the air with a total atmospheric pressure of 760. torr. Calculate the mole fraction of O_2 present.

$$\text{MOLE FRACTION} = \frac{160.\ \text{TORR}}{760.\ \text{TORR}} = 0.211$$

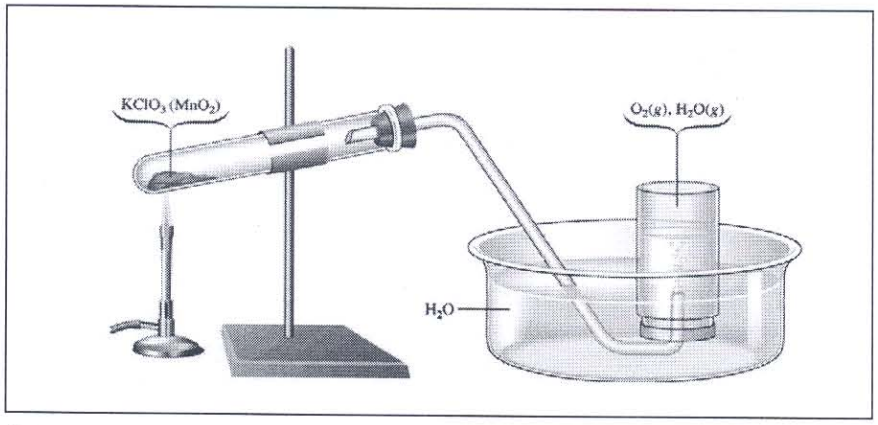
NO UNITS!

GASES AT THE SAME TEMPERATURE - THIS IS A FRACTION OF THE TOTAL GAS SAMPLE.

3) The mole fraction of nitrogen in the air is 0.7808. Calculate the partial pressure of N_2 in the air when the atmospheric pressure is 760 torr.

$P_{N_2} = (0.7808)\ 760 \text{ TORR} = 593 \text{ TORR}$

(0.7808: MOLE FRACTION; 760 TORR: P_T; 593 TORR: P_{N_2})



4) A sample of solid potassium chlorate was heated in a test tube and decomposed by the following reaction:

$$2\ KClO_{3\ (s)} \rightarrow 2\ KCl_{\ (s)} + 3\ O_{2\ (g)}$$

The oxygen produced was collected by displacement of water at 22 ^{0}C at a total pressure of 754 torr. The volume of the gas collected was 0.650 liters, and the vapor pressure of water at 22 ^{0}C is 21.0 torr. Calculate the partial pressure of O_2 in the gas collected **AND** the mass of $KClO_3$ in the sample that was decomposed.

$P_T = P_{O_2} + P_{H_2O} = 754 \text{ TORR}$; $P_{O_2} = 754 \text{ TORR} - 21.0 \text{ TORR} =$

$P_{O_2} = 733 \text{ TORR}$

$PV = nRT$

GAS STOICHIOMETRY! STEP 1) BALANCE THE EQUATION - DONE

STEP 2) CHANGE WHAT IS GIVEN TO MOLES: $P_{O_2} = 733 \text{ TORR}$, $T = 22^\circ C$, $V = 0.65$ L

$733 \text{ TORR} \mid \frac{1 \text{ ATM}}{760 \text{ TORR}}$

$n_{O_2} = \frac{PV}{RT} = \frac{(0.964 \text{ ATM})(0.650 \text{ L})(\text{mol}\cdot\text{K})}{(0.0821 \text{ ATM}\cdot\text{L})(295 \text{ K})} = 0.02588 \text{ mol } O_2$

STEP 3) USE MOLE RATIO

STEP 4) CHANGE TO DESIRED UNITS.

$$0.02588 \text{ mol } O_2 \mid \frac{2 \text{ mol } KClO_3}{3 \text{ mol } O_2} \mid \frac{122.55 \text{ g}}{1 \text{ mol } KClO_3} = 2.11 \text{ g } KClO_3$$