AP CHEMISTRY

TOPIC 3: GASES, PART C

Day 38:

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

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1) (**PART I**) A piece of solid carbon dioxide, with a mass of 13.3 grams is placed in a 5.3 liter otherwise empty container at 25 ^{0}C. What is the pressure in the container after all the carbon dioxide vaporizes? (**PART II**) If 13.3 grams of solid carbon dioxide were placed in the same container but the container already contained air at 750 torr, what would be the partial pressure of carbon dioxide and the total pressure in the container after the carbon dioxide vaporizes?

PART I:

Answers:

$$\frac{13.3\ g\ CO_2}{} \times \frac{1\ mol\ CO_2}{44.011\ g} = 0.302\ mol\ CO_2$$

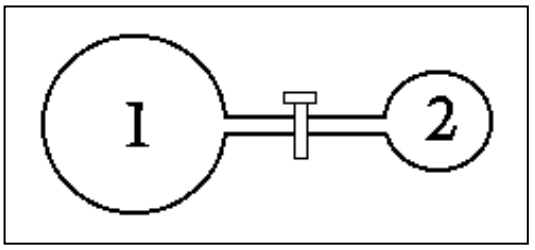
$$P_{CO_2} = \frac{nRT}{V} = \frac{(0.302\ mol)(0.0821\ atm \cdot L)(298\ K)}{5.3\ L \quad mol \cdot K} = 1.39\ atm$$

PART II:

$$\frac{750\ torr}{} \times \frac{1\ atm}{760\ torr} = 0.987\ atm$$

$$P_T = P_{CO_2} + P_{Air} = 1.39\ atm + 0.987\ atm = 2.38\ atm$$

2) Consider the flasks in the diagram to the right. In flask 1, 3.00 L H_2 at 520 torr. In flask 2, 1.00 L He at 0.350 atm. What are the final partial pressures of of H_2 and He after the stopcock between the two flasks is opened? (Assume the final volume is 4.00 liters). What is the total pressure (in torr)?



Answers:

Use the relationship $\boldsymbol{P_1V_1 = P_2V_2}$ *since* $\boldsymbol{T}$ *and* $\boldsymbol{n}$ *remain a constant*

$$H_2 : P_2 = \frac{P_1V_1}{V_2} = \frac{(0.648\ atm)(3.00\ L)}{4.00\ L} = 0.513\ atm$$

$$He : P_2 = \frac{P_1V_1}{V_2} = \frac{(0.350\ atm)(1.00\ L)}{4.00\ L} = 0.0875\ atm$$

$$P_{total} = P_{H_2} + P_{He} = 0.513\ atm + 0.0875\ atm = 0.601\ atm$$

$$\frac{0.601\ atm}{} \times \frac{760\ torr}{1\ atm} = 457\ torr$$

3) A sample of a mixture of gases with a pressure of 575 torr contains 50.0 % argon and 50.0 % xenon gas by mass. What are the partial pressures of the individual gases?

Answers:

If we had a 100 gram sample of gas, we would have 50 g Ar and 50 g Xe.

$$n_{Ar} = \frac{50.0\ g\ Ar}{} \times \frac{1\ mol\ Ar}{39.948\ g} = 1.25\ mol\ Ar$$

$$n_{Xe} = \frac{50.0\ g\ Xe}{} \times \frac{1\ mol\ Xe}{131.29\ g} = 0.381\ mol\ Xe$$

$$\chi_{Ar} = \frac{n_{Ar}}{n_{Ar}\ +\ n_{Xe}} = \frac{1.25\ mol}{1.25\ mol\ +\ 0.381\ mol} = 0.7664$$

$$\boldsymbol{P_{Ar} = (\chi_{Ar})(P_{total}) = 0.7664 \ \ x \ \ 575\ torr = 441\ torr}$$

$$\boldsymbol{P_{Xe} = 575\ torr - 441\ torr = 134\ torr}$$

4) Helium is collected over water at 25 ^{0}C and 1.00 atm total pressure. What total volume of gas must be collected to obtain 0.586 grams of helium? (At 25 ^{0}C the vapor pressure of water is 23.8 torr.)

Answers:

To calculate the volume of the gas, we can use P_{total} and n_{total}

$V = \frac{n_{total}\ RT}{P_{total}}$, *Since moles for water is unknown, we will use P_{He} and n_{He}.*

$$P_{He}\ +\ P_{H_2O} = 1.00\ atm\ =\ 760\ torr = P_{He} + 23.8\ torr, \quad = P_{He} = 736\ torr$$

$$n_{He} = \frac{0.586\ g\ He}{} \times \frac{1\ mol\ He}{4.0026\ g} = 0.1464\ mol\ He$$

$$V = \frac{n_{He}\ RT}{P_{He}} = \frac{(0.1464\ mol)(0.0821\ atm \cdot L)(298\ K)}{0.9684\ atm \quad mol \cdot K} = \ 3.7\ L$$

5) A mixture of 3.25 grams of hydrogen gas an 3.25 grams of helium is placed in a 2.50 liter container at 27.0 ^{0}C. Calculate the partial pressure of each gas and the total pressure.

Answers:

$$n_{H_2} = \frac{3.25\ g\ H_2}{} \times \frac{1\ mol\ H_2}{2.0158\ g} = 1.612\ mol\ H_2$$

$$n_{He} = \frac{3.25\ g\ He}{} \times \frac{1\ mol\ He}{4.0026\ g} = 0.812\ mol\ He$$

$$P_{H_2} = \frac{nRT}{V} = \frac{(1.612\ mol)(0.0821\ atm \cdot L)(300\ K)}{2.50\ L \quad mol \cdot K} = 15.88\ atm$$

$$P_{He} = \frac{nRT}{V} = \frac{(0.812\ mol)(0.0821\ atm \cdot L)(300\ K)}{2.50\ L \quad mol \cdot K} = 8.00\ atm$$

$$P_{total} = P_{H_2} + P_{He} = 15.88\ atm + 8.00\ atm = 23.9\ atm$$