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Gas Stoich Problems

1. (5 pts) How many liters of methane are present in 37.4 grams of methane, CH_4, at STP?

$$37.4\,g\,CH_4 \times \frac{1\,mol\,CH_4}{16.04\,g\,CH_4} \times \frac{22.4\,L\,CH_4}{1\,mol\,CH_4} = \underline{52.2}\ L\,CH_4$$

2. (5 pts) How many chlorine gas molecules are present in 3.27 L of chlorine gas at STP?

$$3.27\,L\,Cl_2 \times \frac{1\,mol\,Cl_2}{22.4\,L\,Cl_2} \times \frac{6.02\times10^{23}\,molecules\,Cl_2}{1\,mol\,Cl_2} = \underline{8.79\times10^{22}\,Cl_2\,molecules}$$

3. (7 pts) Burning 10.0 g of iron (II) sulfide produces how many liters of sulfur dioxide at STP?

$$4\,FeS\,(s) + 7\,O_2\,(g) \rightarrow 2\,Fe_2O_3\,(s) + 4\,SO_2\,(g)$$

10.0 g ... ? L

$$10.0\,g\,FeS \times \frac{1\,mol\,FeS}{87.91\,g\,FeS} \times \frac{4\,mol\,SO_2}{4\,mol\,FeS} \times \frac{22.4\,L\,SO_2}{1\,mol\,SO_2} = \underline{2.55}\ L\,SO_2$$

4. (7 pts) How many molecules of magnesium carbonate are needed to produce 75.1 L of carbon dioxide gas at STP? $MgCO_3\,(s) \rightarrow MgO\,(s) + CO_2\,(g)$

? molecules ... 75.1 L

$$75.1\,L \times \frac{1\,mol\,CO_2}{22.4\,L\,CO_2} \times \frac{1\,mol\,MgCO_3}{1\,mol\,CO_2} \times \frac{6.02\times10^{23}\,MgCO_3\,molecules}{1\,mol\,MgCO_3} = \underline{2.02\times10^{24}\,MgCO_3}\ molecules$$

5. (10 pts) Mercury (II) oxide decomposes into liquid mercury and oxygen gas. How many grams of mercury (II) oxide are needed to make 15.0 L of oxygen gas at STP?

mecury (II) oxide → mercury + oxygen

$$2\,HgO \rightarrow 2\,Hg\,(l) + O_2\,(g)$$

? g ... 15.0 L

$$15.0\,L\,O_2 \times \frac{1\,mol\,O_2}{22.4\,L\,O_2} \times \frac{2\,mol\,HgO}{1\,mol\,O_2} \times \frac{216.6\,g\,HgO}{1\,mol\,HgO} = \underline{290.}\ g\,HgO$$

6. (12 pts) A mixture of 1.00 g hydrogen gas and 1.00 g helium gas were placed in a 1.00 L container at 27°C. Calculate the partial pressure of each gas and the total pressure.

$$P_{H_2} = \frac{\left(1.00\text{g } H_2 \times \frac{1\text{ mol } H_2}{2.016\text{g } H_2}\right)\left(\frac{.0821\text{ atm}\cdot L}{\text{mol}\cdot K}\right)(300.\text{ K})}{1.00\text{ L}} = 12.2\text{ atm}$$

$$P_{He} = \frac{\left(1.00\text{g He} \times \frac{1\text{ mol He}}{4.003\text{g He}}\right)\left(\frac{.0821\text{ atm}\cdot L}{\text{mol}\cdot K}\right)(300.\text{ K})}{1.00\text{ L}} = 6.15\text{ atm}$$

$$P_{Total} = P_{H_2} + P_{He} = 12.2\text{ atm} + 6.2\text{ atm} = 18.4\text{ atm}$$

7. (8 pts) The method used by Joseph Priestly to obtain oxygen made by thermal decomposition of mercury (II) oxide:

$$2\,HgO\,(s) \rightarrow 2\,Hg\,(l) + O_2\,(g)$$

What volume of oxygen gas, measured at 30.°C and 725 torr, can be produced from the complete decomposition of 4.10 g of mercury (II) oxide?

$$4.10\text{g } HgO \times \frac{1\text{ mol } HgO}{216.6\text{g } HgO} \times \frac{1\text{ mol } O_2}{2\text{ mol } HgO} = .00946\text{ mol } O_2$$

$$PV = nRT$$

$$V = \frac{nRT}{P} = \frac{(.00946\text{ mol})\left(\frac{.0821\text{ atm}\cdot L}{\text{mol}\cdot K}\right)(303\text{ K})}{\left(725\text{ torr} \times \frac{1\text{ atm}}{760\text{ torr}}\right)} = .247\text{ L } O_2$$

8. (10 pts) A gas consisting of only carbon and hydrogen has an empirical formula of CH_2. The gas has a density of 1.65 g/L at 27°C and 734 torr. Determine the molar mass and molecular formula of the gas.

$$n = \frac{PV}{RT} = \frac{\left(734\text{ torr} \times \frac{1\text{ atm}}{760\text{ torr}}\right)(1\text{ L})}{\left(\frac{.0821\text{ atm}\cdot L}{\text{mol}\cdot K}\right)(300.\text{ K})} = .0392\text{ mol}$$

$$\text{molar mass} = \frac{1.65\text{ g}}{\text{mol}}$$

$$\text{molar mass} = 42.3\text{ g/mol}$$

$$CH_2 = 14$$

$$\frac{42.3}{14} = 3$$

$$CH_2 \times 3 = C_3H_6 \text{ molecular formula}$$