

KEY

Gas Stoichiometry Worksheet

Directions: Use the gas laws we have learned to solve each of the following problems. *Each of the chemical equations must first be balanced.* Show all your work for credit.

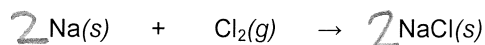
1. When calcium carbonate is heated strongly, carbon dioxide gas is released according to the following equation:



What volume of $\text{CO}_2(\text{g})$, measured at STP, is produced if 15.2 grams of $\text{CaCO}_3(\text{s})$ is heated?

$$\frac{15.2\text{g CaCO}_3}{100.1\text{g}} \times \frac{1\text{mol CaCO}_3}{1\text{mol CaCO}_3} \times \frac{1\text{mol CO}_2}{1\text{mol CaCO}_3} \times \frac{22.4\text{L CO}_2}{1\text{mol CO}_2} = 3.40\text{L CO}_2$$

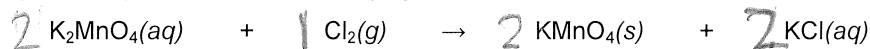
2. The synthesis of sodium chloride occurs according to the reaction:



What volume of chlorine at STP is necessary for the complete reaction of 4.81 grams of sodium metal?

$$\frac{4.81\text{g Na}}{23.0\text{g}} \times \frac{1\text{mol Na}}{2\text{mol Na}} \times \frac{1\text{mol Cl}_2}{1\text{mol Cl}_2} \times \frac{22.4\text{L Cl}_2}{1\text{mol Cl}_2} = 2.34\text{L Cl}_2$$

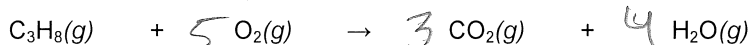
3. Potassium permanganate is produced commercially by the this reaction:



What volume of chlorine gas at STP would be required to produce 10.0 grams of KMnO_4 ?

$$\frac{10.0\text{g}}{158\text{g MnO}_4} \times \frac{1\text{mol MnO}_4}{2\text{mol MnO}_4} \times \frac{1\text{mol Cl}_2}{1\text{mol}} \times \frac{22.4\text{L}}{1\text{mol}} = 7.09\text{Liters}$$

4. Consider the following *unbalanced* chemical equation for the combustion of propane:



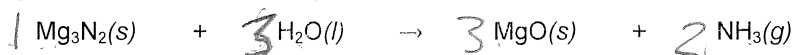
What volume of oxygen at 25°C and 1.04 atm is needed for the complete combustion of 5.53 grams of propane?

$$P = 1.04 \text{ atm} \quad T = 25^\circ\text{C} = 298 \text{ K} \quad R = 0.0821 \frac{\text{L}\cdot\text{atm}}{\text{K}\cdot\text{mol}}$$

$$\frac{5.53 \text{ g C}_3\text{H}_8}{44 \text{ g}} \times \frac{1 \text{ mol C}_3\text{H}_8}{1 \text{ mol C}_3\text{H}_8} \times \frac{5 \text{ mol O}_2}{1 \text{ mol C}_3\text{H}_8} = 0.628 \text{ mol O}_2$$

$$PV = nRT \rightarrow V = \frac{nRT}{P} = \frac{(0.628 \text{ mol})(0.0821)(298 \text{ K})}{(1.04 \text{ atm})} = 14.8 \text{ L O}_2$$

5. If water is added to magnesium nitride, ammonia gas is produced when the mixture is heated.



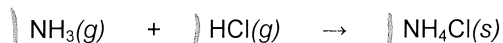
When excess water is added to 10.3 grams of magnesium nitride, what volume of ammonia gas would be collected at 24°C and 752 mmHg?

$$T = 24^\circ\text{C} + 273 = 297 \text{ K} \quad P = \frac{752 \text{ mmHg}}{760 \text{ mmHg}} = 0.989 \text{ atm}$$

$$\frac{10.3 \text{ g Mg}_3\text{N}_2}{100.9 \text{ g Mg}_3\text{N}_2} \times \frac{1 \text{ mol Mg}_3\text{N}_2}{1 \text{ mol Mg}_3\text{N}_2} \times \frac{2 \text{ mol NH}_3}{1 \text{ mol Mg}_3\text{N}_2} = 0.204 \text{ mol NH}_3$$

$$PV = nRT \rightarrow V = \frac{nRT}{P} = \frac{(0.204 \text{ mol})(0.0821)(297 \text{ K})}{(0.989 \text{ atm})} = 5.03 \text{ L NH}_3$$

6. Ammonia and gaseous hydrogen chloride combine to form ammonium chloride according to this equation:



If 4.21 L of NH₃(g) at 27°C and 1.02 atm is combined with 5.35 L of HCl(g) at 26°C and 0.998 atm, what mass of NH₄Cl(s) will be produced? Which gas is the limiting reactant? Which gas is the excess reactant?

NH₃ {

$$V = 4.21 \text{ L NH}_3$$

$$T = 27 + 273 = 300 \text{ K}$$

$$P = 1.02 \text{ atm}$$

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

$$PV = nRT \rightarrow n = \frac{PV}{RT} = \frac{(1.02 \text{ atm})(4.21 \text{ L})}{(0.0821)(300 \text{ K})} = 0.174 \text{ mol}$$

HCl {

$$V = 5.35 \text{ L}$$

$$T = 26^\circ\text{C} + 273 = 299 \text{ K}$$

$$P = 0.998 \text{ atm}$$

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

$$n = \frac{PV}{RT} = \frac{(0.998 \text{ atm})(5.35 \text{ L})}{(0.0821)(299 \text{ K})} = 0.218 \text{ mol}$$

$$\frac{0.174 \text{ mol NH}_3}{1 \text{ mol NH}_3} \times \frac{1 \text{ mol NH}_4\text{Cl}}{1 \text{ mol NH}_3} \times \frac{53.5 \text{ g}}{1 \text{ mol NH}_4\text{Cl}} = 9.1 \text{ g NH}_4\text{Cl}$$

less moles, must be **LB**

↑
excess