

Stoichiometry



"In solving a problem of this sort, the grand thing is to be able to reason backward. This is a very useful accomplishment, and a very easy one, but people do not practice it much."

Sherlock Holmes, in Sir Arthur Conan Doyle's A Study in Scarlet

Stoichiometry - The study of quantities of materials consumed and produced in chemical reactions.

CA Standards

Students know how to describe chemical reactions by writing balanced equations.

Students know the quantity one mole is set by defining one mole of carbon 12 atoms to have a mass of exactly 12 grams.

Students know one mole equals 6.02×10^{23} particles (atoms or molecules).

Students know how to determine the molar mass of a molecule from its chemical formula and a table of atomic masses and how to convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.

Students know how to calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products and the relevant atomic masses.

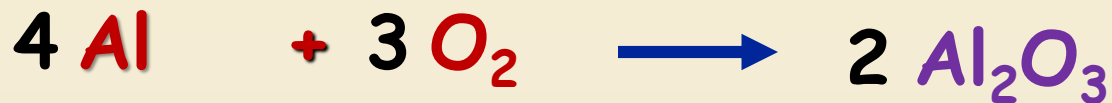
Calculating Masses of Reactants and Products

- 1. Balance the equation.**
- 2. Convert mass or volume to moles, if necessary.**
- 3. Set up mole ratios.**
- 4. Use mole ratios to calculate moles of desired substituent.**
- 5. Convert moles to mass or volume, if necessary.**

Working a Stoichiometry Problem

6.50 grams of aluminum reacts with an excess of oxygen. How many grams of aluminum oxide are formed.

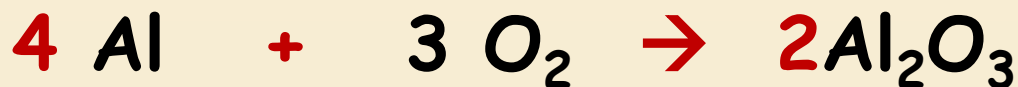
1. Identify reactants and products and write the balanced equation.



- Every reaction needs a yield sign!
- What are the reactants?
- What are the products?
- What are the balanced coefficients?

Working a Stoichiometry Problem

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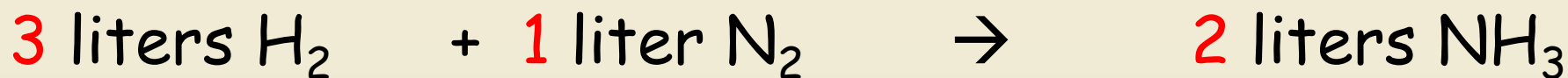
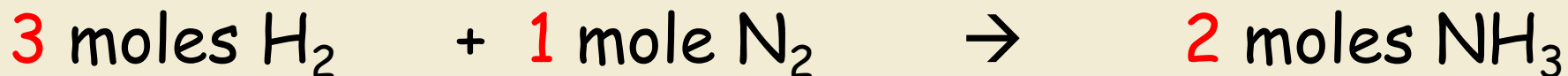
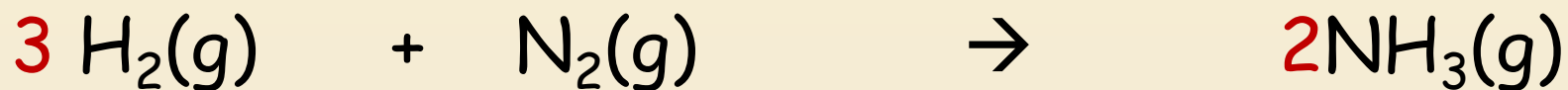


$$6.50 \times 2 \times 101.96 \div 26.98 \div 4 = 12.3 \text{ g Al}_2\text{O}_3$$

6.50 g Al	1 mol Al	2 mol Al₂O₃	101.96 g Al ₂ O ₃	= ? g Al ₂ O ₃
	26.98 g Al	4 mol Al	1 mol Al₂O₃	

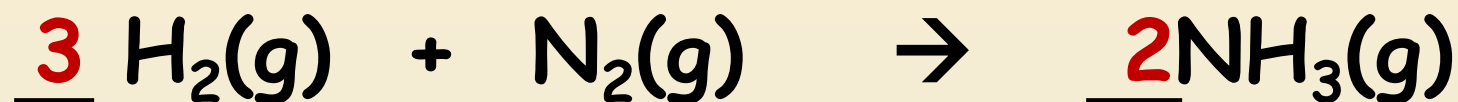
Gas Stoichiometry #1

If reactants and products are at the same conditions of temperature and pressure, then mole ratios of gases are also volume ratios.



Gas Stoichiometry #2

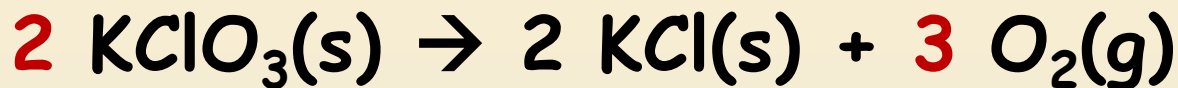
How many liters of ammonia can be produced when 12 liters of hydrogen react with an excess of nitrogen?



$$\frac{12 \cancel{\text{ L H}_2}}{\quad} \left| \frac{2 \text{ L NH}_3}{3 \cancel{\text{ L H}_2}} \right. = 8.0 \text{ L NH}_3$$

Gas Stoichiometry #3

How many liters of oxygen gas, at STP, can be collected from the complete decomposition of 50.0 grams of potassium chlorate?



50.0 g KClO₃	1 mol KClO₃	3 mol O₂	22.4 L O ₂
	122.55 g KClO₃	2 mol KClO₃	1 mol O₂

= 13.7 L O₂

Gas Stoichiometry #4

How many liters of oxygen gas, at 37.0°C and 0.930 atmospheres, can be collected from the complete decomposition of 50.0 grams of potassium chlorate?



$$\frac{50.0 \text{ g } \cancel{\text{KClO}_3}}{122.55 \text{ g } \cancel{\text{KClO}_3}} \times \frac{1 \text{ mol } \cancel{\text{KClO}_3}}{2 \text{ mol } \cancel{\text{KClO}_3}} \times \frac{3 \text{ mol O}_2}{1} = 0.612 \text{ mol O}_2$$

$$V = \frac{nRT}{P} = \frac{(0.612 \text{ mol})(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(310 \text{ K})}{0.930 \text{ atm}} = 16.7 \text{ L}$$