

Session 5: LECTURE OUTLINE (Section H & Sections L.1 & L.2)

- I. Writing down the chemical reaction
 - a. Reactants
 - b. Products
 - c. Skeletal equation
 - d. Law of conservation of mass
 - e. Stoichiometric coefficient
 - f. State symbols
 - g. Placement of symbol for heat or catalyst over arrow
- II. Balancing the chemical reaction
 - a. Importance of expressing all components correctly
 - b. Balance by inspection
- III. Reaction Stoichiometry
 - a. mole to mole predictions
 - b. mass to mass predictions

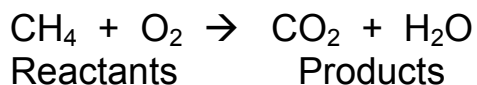
suggested problems: pp F60-F61 H.1, H.3, H.7, H.9, H.11
pp F86-F87 L.3, L.5, L.7

CHEMICAL EQUATIONS

1. precisely describe a chemical change
2. symbolize the chemical change using chemical formulae and an arrow
3. symbols on the left are reactants
4. symbols on the right are products
5. based on experimental observation, eg

Methane burns in oxygen to give carbon dioxide and water

Method: a. write down reaction

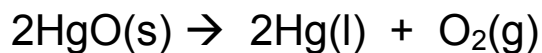


b. balance equation (Law of Conservation of Mass)

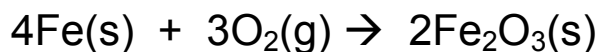


More examples:

Mercury(II)oxide decomposes into its elements.



Iron combines with oxygen to yield iron(III)oxide.



Solid sodium plus liquid water react to yield hydrogen gas plus a solution of sodium hydroxide and heat.



The numbers (coefficients) used to balance the elements on each side of the equation can be interpreted as numbers of moles of each of the substances. These are called stoichiometric coefficients and represent the number ratio of element and/or compound across a balanced chemical equation.

Reaction Stoichiometry

Butane burns completely in oxygen to yield carbon dioxide and water.



How many moles of O_2 are required to react completely with 5.6 moles C_4H_{10} ?

This question can be answered very easily based on the mole:mole ratios that are inherent in a balanced chemical equation. For example for the above equation 2 moles of C_4H_{10} will react with every 13 moles of O_2 . This can also be stated as an equality: 2 mole $\text{C}_4\text{H}_{10} = 13$ mole O_2 , this equality can be interpreted as a conversion factor or “per expression”: 2 moles C_4H_{10} per 13 moles O_2 which can be written in the form of a conversion factor as follows

$$\frac{2 \text{ mole } \text{C}_4\text{H}_{10}}{13 \text{ mole } \text{O}_2} \quad \text{or} \quad \frac{13 \text{ mole } \text{O}_2}{2 \text{ mole } \text{C}_4\text{H}_{10}}$$

Similar expressions can be written for all the reactants and products across a balanced chemical reaction.

We can use this “per expression” as a conversion factor to answer the question.

Given: 5.6 moles C_4H_{10}

Wanted: # moles O_2 needed to react

Conversion: from moles C_4H_{10} to moles O_2

Conversion factor: $\frac{13 \text{ mole } \text{O}_2}{2 \text{ mole } \text{C}_4\text{H}_{10}}$

$$\text{Solution: } \frac{5.6 \text{ moles } \text{C}_4\text{H}_{10}}{1} \times \frac{13 \text{ mole } \text{O}_2}{2 \text{ mole } \text{C}_4\text{H}_{10}} = 36.4 \text{ mole } \text{C}_4\text{H}_{10}$$

Similarly the following can be answered:

How many moles of H₂O are produced when 0.0142 moles of C₄H₁₀ burn in excess O₂?



Given: 0.0142 mole C₄H₁₀

Wanted: # moles H₂O produced

Conversion: from moles C₄H₁₀ to moles H₂O

Conversion factor: $\frac{10 \text{ mole H}_2\text{O}}{2 \text{ mole C}_4\text{H}_{10}}$

Solution: $\frac{0.0142 \text{ mole C}_4\text{H}_{10} \left| \frac{10 \text{ mole H}_2\text{O}}{2 \text{ mole C}_4\text{H}_{10}} \right.}{1} = 0.071 \text{ mole H}_2\text{O}$

Using our knowledge of the relationship between mass and number of atoms or compounds, that is molar mass, we can also very easily expand our understanding of reaction stoichiometry to include gram to gram conversions:

For example we can answer the following:

How many grams of butane are required to react completely with 47.2 g O₂?



Given: 47.2 g O₂

Wanted: # grams of C₄H₁₀ needed to react completely

Conversion: g O₂ to moles O₂ to moles C₄H₁₀ to grams C₄H₁₀

Conversion factors: $\frac{16 \text{ g O}_2}{1 \text{ mole O}_2}$ $\frac{2 \text{ mole C}_4\text{H}_{10}}{13 \text{ mole O}_2}$ $\frac{58 \text{ g C}_4\text{H}_{10}}{1 \text{ mole C}_4\text{H}_{10}}$

Solution:

$$\frac{47.2 \text{ g O}_2}{1} \times \frac{1 \text{ mole O}_2}{16 \text{ g O}_2} \times \frac{2 \text{ mole C}_4\text{H}_{10}}{13 \text{ mole O}_2} \times \frac{58 \text{ g C}_4\text{H}_{10}}{1 \text{ mole C}_4\text{H}_{10}} = 13.2 \text{ g O}_2$$