STOICHIOMETRY

- **Stoichiometry** refers to the calculations involving chemical reactions in which we have to determine the amounts of reactants and/or products.
- The balanced equation of the chemical reaction is a very powerful summary of conversion factors that can be used for these calculations.
- Note that the equation is written in **mole** units but the measurement of reactants and products is in **mass** units.

Example: Combustion of propane.

\[
\text{MM (g/mole): } \begin{array}{c} 44.10 \quad 32.00 \quad 44.01 \quad 18.02 \\
C_3H_8(g) \quad + \quad 5 \quad O_2(g) \quad \rightarrow \quad 3 \quad CO_2(g) \quad + \quad 4 \quad H_2O(g)
\end{array}
\]

<table>
<thead>
<tr>
<th>Moles:</th>
<th>1</th>
<th>5</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass (g):</td>
<td>44.10 g</td>
<td>160.0 g</td>
<td>132.0 g</td>
<td>72.06 g</td>
</tr>
</tbody>
</table>

Note that the MM is a conversion factor; for example:

\[1 \text{ mole of } C_3H_8 = 44.10 \text{ g of } C_3H_8\]

Calculation examples:

a) How many moles of \(O_2\) are necessary to consume 2.50 moles of \(C_3H_8\)?

\[
\frac{2.50 \text{ moles } C_3H_8 \times 5 \text{ moles } O_2}{1 \text{ mole } C_3H_8} = 12.5 \text{ moles } O_2
\]

b) If 1,000.0 kg of \(CO_2\) have been produced, how many kg of \(C_3H_8\) were consumed?

\[
\frac{1,000.0 \text{ kg } CO_2 \times 44.10 \text{ kg } C_3H_8}{132.0 \text{ kg } CO_2} = 334.09 \text{ kg } C_3H_8
\]

In real reactions, the reactants may be initially present in any amounts. In this case, the **limiting reactant** is the reactant that is present in the smallest stoichiometric amount (and the stoichiometric amount of a reactant is the ratio of the moles initially present to its stoichiometric coefficient).