



Stoichiometry

QUANTITATIVE RELATIONSHIPS IN
CHEMISTRY

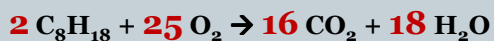
What Is Stoichiometry?

It is the study of the **quantitative** relationships among reactants and products in a chemical reaction



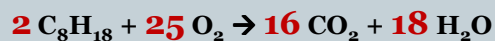
It's All in the Numbers!

The relationships among reactants and products in a chemical reaction are given by the **coefficients** in a balanced chemical equation



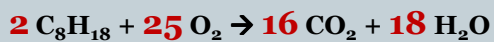
It's All in the Numbers!

The **coefficients** can be interpreted as the number of **molecules** or **moles** of each substance



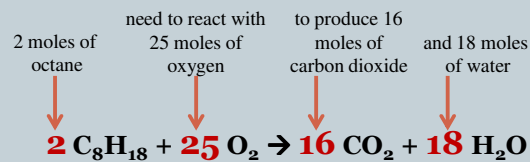
It's All in the Numbers!

We will usually interpret coefficients as the amount of **moles** of each substance since that is more practical in lab work



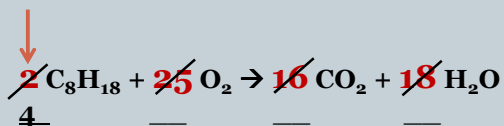
It's All in the Numbers!

The balanced equation below shows that:



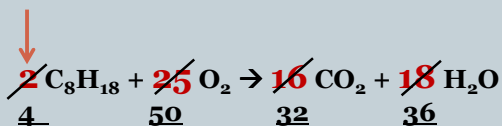
Stoichiometry Allows Predictions

How would the other coefficients change if you doubled the moles of octane to 4 instead of 2?



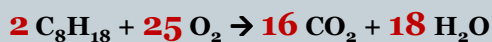
Each Coefficient is Related to the Others

They would double also because every coefficient in a balanced chemical equation is proportionally related to the others



In Chemistry, We Use “Mole Ratios”

A mole ratio is a fraction that allows us to compare **moles** of one substance to **moles** of another substance based on the coefficients



$$\frac{2 \text{ moles C}_8\text{H}_{18}}{25 \text{ moles O}_2}$$

$$\frac{2 \text{ moles C}_8\text{H}_{18}}{18 \text{ moles H}_2\text{O}}$$

$$\frac{18 \text{ moles H}_2\text{O}}{2 \text{ moles C}_8\text{H}_{18}}$$

$$\frac{25 \text{ moles O}_2}{16 \text{ moles CO}_2}$$

What Do We Do With Mole Ratios?

We use mole ratios as conversion factors in dimensional analysis problems to help us predict...

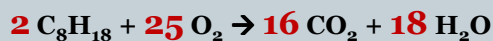
how much product can be made or
how much reactant is needed
during a chemical reaction

Let's see how....

Example 1: A “Mole-to-Mole” Problem

How many **moles** of water are produced from burning 37.0 **moles** of octane?

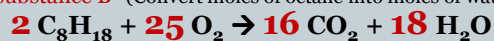
Step 1: Write a **balanced** equation



Example 1: A “Mole-to-Mole” Problem

How many **moles** of water are produced from burning 37.0 **moles** of octane?

Step 2: Convert moles of “substance A” into moles of “substance B” (Convert moles of octane into moles of water)



$$37.0 \cancel{\text{mol C}_8\text{H}_{18}} \times \frac{18 \text{ mol H}_2\text{O}}{2 \cancel{\text{mol C}_8\text{H}_{18}}} = 333 \text{ mol H}_2\text{O}$$

This “mole ratio” allowed us to convert from octane to water



Example 2: A "Mass-to-Mass" Problem

How many **grams** of water are produced from burning 312 **grams** of octane?

The only difference with this problem is that:

1. You have to convert grams to moles before you can multiply by the "mole to mole ratio"
2. You have to convert moles to grams after you multiply by the "mole to mole ratio"

Summary of Stoichiometry Problems

1. Write a balanced chemical equation

2. Convert given substance "A" into moles

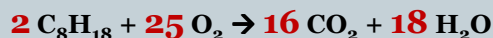
4. Convert moles of substance "B" to desired units

3. Convert moles of "A" into moles of "B" (mole/mole ratio)

Example 2: A "Mass-to-Mass" Problem

How many **grams** of water are produced from burning 312 **grams** of octane?

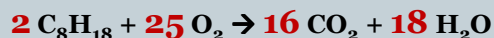
Step 1: Write a **balanced** equation



Example 2: A "Mass-to-Mass" Problem

How many **grams** of water are produced from burning 312 **grams** of octane?

Step 2: Convert given substance, "A" into moles



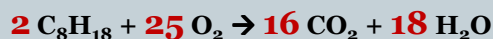
$$312 \text{ grams } \text{C}_8\text{H}_{18} \times \frac{1 \text{ mol } \text{C}_8\text{H}_{18}}{114.26 \text{ grams}} = 2.73 \text{ mol } \text{C}_8\text{H}_{18}$$

114.26 is the "molar mass" of octane
 $12.01(8) + 1.01(18) = 114.26\text{g}$

Example 2: A "Mass-to-Mass" Problem

How many **grams** of water are produced from burning 312 **grams** of octane?

Step 3: Convert moles of "A" into moles of "B"



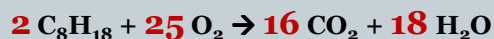
$$2.73 \text{ mol } \text{C}_8\text{H}_{18} \times \frac{18 \text{ mol } \text{H}_2\text{O}}{2 \text{ mol } \text{C}_8\text{H}_{18}} = 24.6 \text{ mol } \text{H}_2\text{O}$$

The mole-to-mole ratio allows you to compare moles of water to moles of octane

Example 2: A "Mass-to-Mass" Problem

How many **grams** of water are produced from burning 312 **grams** of octane?

Step 4: Convert moles of "B" to desired units (grams)

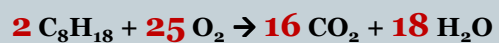


$$24.6 \text{ mol } \text{H}_2\text{O} \times \frac{18.02 \text{ g } \text{H}_2\text{O}}{1 \text{ mol } \text{H}_2\text{O}} = 443 \text{ g } \text{H}_2\text{O}$$

This is the "molar mass" of water.
 $1.01(2) + 16.00(1) = 18.02\text{g}$

In Summary

According to the balanced reaction,



Burning 312 grams of octane will result in the production of 443 grams of water.

Summary of Stoichiometry Problems

1. Write a balanced chemical equation

2. Convert given substance "A" into moles

4. Convert moles of substance "B" into desired units

3. Convert moles of "A" into moles of "B" (mole/mole ratio)

Why Learn Stoichiometry?

It allows you to determine...

The amount of **reactant(s)** you need
and

The amount of **product(s)** you will make

