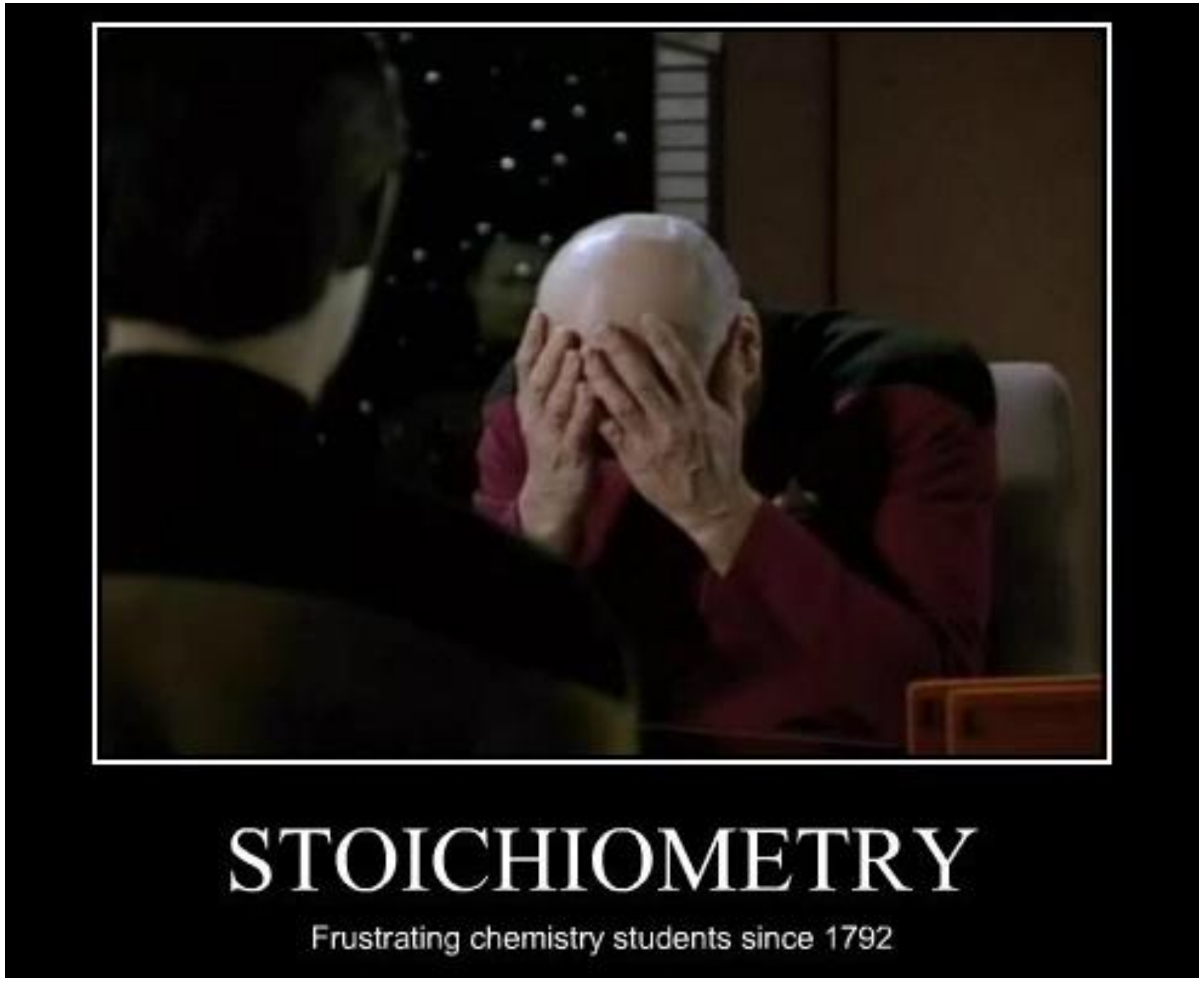
Rates & Stoichiometry



Outcomes:

- Relate the rate of formation of a product to the rate of disappearance of a reactant given experimental rate data and reaction stoichiometry.

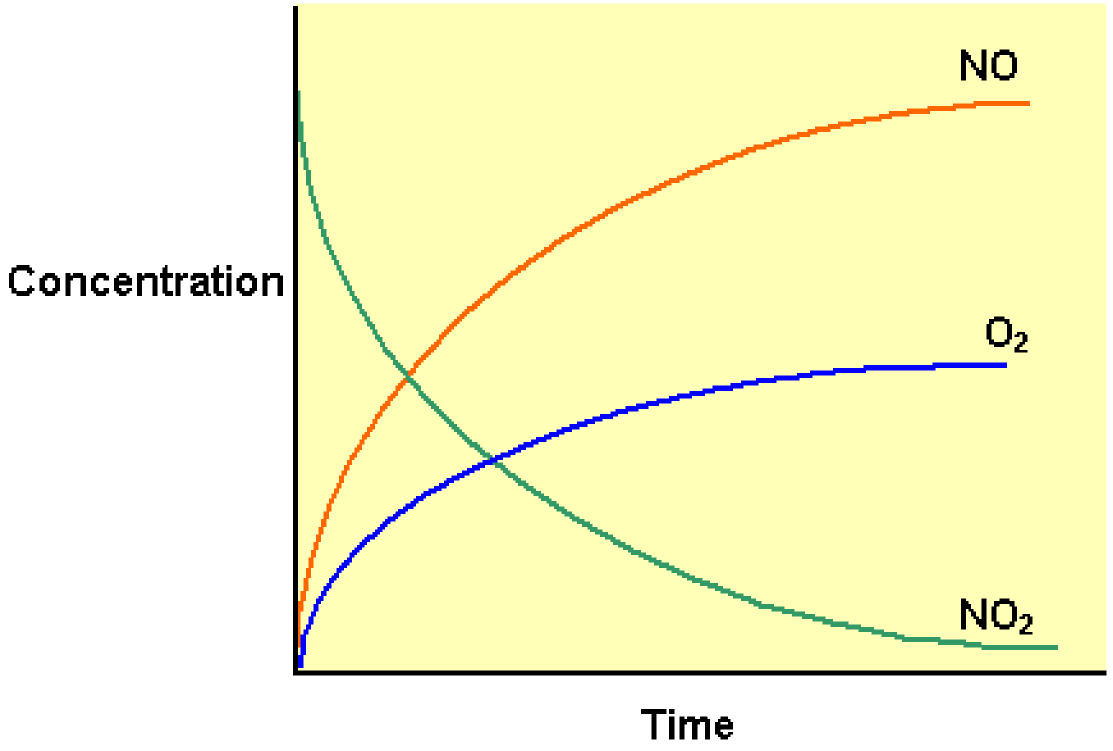
Rates & Stoich:

The **STOICHIOMETRY** of a chemical reaction can be used to determine the **RATE** of **DECOMPOSITION** of **REACTANTS**, OR, the rate of **PRODUCTION** of **PRODUCTS**.

Example:

Given: $2NO_{2(g)} \rightarrow 2NO_{(g)} + O_{2(g)}$

The graph will appear as:



Rates & Stoich:

$2NO_2 \rightarrow 2NO + O_2$

$RATE = \frac{\Delta[O_2]}{\Delta t} = \frac{1}{2}\frac{\Delta[NO]}{\Delta t} = -\frac{1}{2}\frac{\Delta[NO_2]}{\Delta t}$

From the graph, it can be seen that:

- The rate of **DECOMPOSITION** of **NO_2** is **EQUAL** to the **PRODUCTION** of **NO**. The **MOLAR RATIO** is **1:1**.

- This means as **ONE MOLECULE** of **NO_2** is **DECOMPOSED**, one molecule of **NO** is **CREATED**.

  → Their rates should be **EQUAL**.

- The rate of **PRODUCTION** of **OXYGEN** is **HALF** that of the **NO**. The molar **RATIO 2:1**

  → The rate of **PRODUCTION** of **NO** should be **DOUBLE** that of the **OXYGEN**.

Therefore,

$$Rate = -\frac{1}{2}\cdot\frac{\Delta[NO_2]}{\Delta t} = \frac{1}{2}\cdot\frac{\Delta[NO]}{\Delta t} = \frac{\Delta[O_2]}{\Delta t}$$

$$= \frac{\Delta[NO_2]}{\Delta t} = -\frac{\Delta[NO]}{\Delta t} = -2\frac{\Delta[O_2]}{\Delta t}$$

Rates & Stoich:

Examples:

Use the reaction $2NO_{2(g)} \rightarrow 2NO_{(g)} + O_{2(g)}$ to solve the following problems:

1. Given the rate of NO_2 decomposition to be 0.6 M/min, find the rate of formation of O_2.

$$0.6\ \frac{mol}{L \cdot min} \times \frac{1\ mol\ O_2}{2\ mol\ NO_2} = 0.3\ \frac{mol}{L \cdot min}$$

2. If the rate of decomposition of NO_2 is 0.5 mol/Ls, predict the rate of production of BOTH products.

NO: $0.5\ \frac{mol}{L \cdot s} \times \frac{2}{2} = 0.5\ \frac{mol}{L \cdot s}$

$\times \frac{1}{2} = 0.25\ \frac{mol}{L \cdot s}$

Rates & Stoich:

Try this one…

For the reaction 2A + B → 3C, what is the rate of production of C, and the rate of disappearance of B, if A is used up at a rate of 0.60 mol/Ls?

Rate C: $0.6 \frac{mol A}{L \cdot s} \times \frac{3 \, mol C}{2 \, mol A} = 0.9 \frac{mol C}{L \cdot s}$

Rate B: $0.6 \frac{mol}{L \cdot s} \times \frac{1}{2} = 0.3 \frac{mol}{L \cdot s}$