Chemical Reactions

- Transformation of one or more chemical species into new substances
- Reactants $\rightarrow$ Products

Chemical Equations

- Written description of a reaction
- Varying information: physical states, conditions
- Doesn’t necessarily mean it really happens!

$C \text{(diamond)} + O_2 \text{(g)} \rightarrow CO_2 \text{(g)}$
Types of Reactions (unbalanced eqs.)

- "addition" or "combination"
  \[ \text{C}_2\text{H}_4 + \text{H}_2 \rightarrow \text{C}_2\text{H}_6 \]
- "decomposition"
  \[ \text{NH}_4\text{NO}_3 \rightarrow \text{N}_2 + \text{O}_2 + \text{H}_2\text{O} \]
- "substitution" or "displacement"
  \[ \text{Mg} + \text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2 \]
- "combustion" (burning in O\(_2\))
  \[ \text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]

Balancing Equations: Conservation Laws

These properties are conserved, and can be "accounted for."
- number of atoms of each element
- mass
- electric charge
- energy

Balanced Equations

- \[ 2 \text{ CO} + \text{O}_2 \rightarrow 2 \text{ CO}_2 \]
- Coefficients: "reaction ratio"
  How many ...
  - Molecules react with molecules
  - Moles react with moles
  - NOT how many grams react with grams!!!
Balancing Equations

- Find smallest whole number coefficients that satisfy conservation rules
- For many reactions, do this by trial and error
- For some reactions, use more systematic methods

Try balancing these ...

- Burning of acetylene (C\(_2\)H\(_2\)) in a welder's torch:
  \[ \text{C}_2\text{H}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]
- Combustion of TNT (C\(_7\)H\(_5\)N\(_3\)O\(_6\)). Products are CO\(_2\), H\(_2\)O, and N\(_2\)

\[ \text{C}_2\text{H}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]
TNT Equation

\[ \text{C}_7\text{H}_5\text{N}_3\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{N}_2 \]

Stoichiometric ratios

- Once you have a balanced equation, it tells you the relative amounts of the various substances.

\[ \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \]

This reaction has mole:mole ratios of 1:2:1:2