Class #4

Chemical Reactions

CHEM 107
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Chemical Reactions

• Transformation of one or more chemical species into new substances
• Reactants → Products
Chemical Equations

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

\[ \text{C (diamond)} + \text{O}_2 (g) \rightarrow \text{CO}_2 (g) \]

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 \( \text{O}_2 \))
  \[ \text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]
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 (C₂H₂) 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 (C₇H₅N₃O₆). Products are \( \text{CO}_2, \text{H}_2\text{O}, \) and \( \text{N}_2 \)
\[
\text{C}_2\text{H}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}
\]

\[
\text{TNT Equation}
\]

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

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

\[ CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \]

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