Reaction Types

Parts of a chemical equation

REACTANTS → PRODUCTS

- Reactants
  - –what you start with
  - –on the left side of the arrow
- Products
  - –what you end up with
  - –on the right side of the arrow

Indicating physical state

- Letter or two in parentheses after a formula
- solid = (s) ex: ice = $H_2O_{(s)}$
- liquid = (l)
- gas = (g) ex: steam = $H_2O_{(g)}$
- aqueous = (aq) = dissolved in water

Synthesis Reaction

- General form:
- A + B → AB
- key: only one product
- ex: $SO_3 + H_2O \rightarrow H_2SO_4$

Decomposition Reaction

- General form:
- $AB \rightarrow A + B$
- key: only one reactant
- ex: $C_6H_{12}O_6 \rightarrow C + H_2O$

Single Replacement

- General Form: A + BC → AC + B
- key: free element in reactants and products
- note which element is replaced
  - metal replace metals
  - nonmetals replace nonmetals

Single Replacement examples

- $Mg + HCl \rightarrow MgCl_2 + H_2$
- $Zn + CuCl_2 \rightarrow ZnCl_2 + Cu$
- $NaCl + F_2 \rightarrow NaF + Cl_2$

Double Replacement reactions

- General Form: AB + CD → AD + CB
- note: elements listed first in one formula (metals) are listed first in their new formula
- key: not any of the others

Double Replacement examples

- $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
- $BaCl_2 + Na_2SO_4 \rightarrow NaCl + BaSO_4$
- $NH_4Cl + NaOH \rightarrow NaCl + NH_4OH$

Acid/Base Neutralization

- General Form:
  - acid + base → salt + water
- acid: formula starts with H
- base: formula ends with OH
- salt: an ionic compound
  - not an acid or base

Neutralization examples

- $HNO_3 + NaOH \rightarrow H_2O + NaNO_3$
- $Ba(OH)_2 + H_2SO_4 \rightarrow H_2O + BaSO_4$
- $HCl + NaOH \rightarrow NaCl + H_2O$

Combustion reactions

- General form:
  - hydrocarbon + $O_2 \rightarrow CO_2 + H_2O$
- Hydrocarbon = any C,H compound
- ex: $CH_4 + O_2 \rightarrow CO_2 + H_2O$
- ex: $C_8H_{18} + O_2 \rightarrow CO_2 + H_2O$

Balancing Chemical Equations

Law of Conservation of Mass

Matter is neither created nor destroyed in an ordinary chemical reaction:

You have to end with all of the atoms you start with, and…

You cannot end with atoms you did not start with

What is wrong with this picture?

- $H_2 + O_2 \rightarrow H_2O$
- Look at the oxygen
- You start with 2 atoms
- You end with one
- Where did the other one go?
- This is NOT a “balanced equation”

A “balanced” equation

Has equal numbers of atoms of each element in the reactants and in the products.

How do you balance an equation?

- You cannot change subscripts:
- Ex: H_2O is water
- H_2O_2 is hydrogen peroxide
- These are obviously not the same thing

How do you balance an equation?

The only “tool” at your disposal in balancing equations is a “coefficient”

- ✓Whole number
- ✓Written to the left of a formula
- ✓Multiplies the number of atoms of each element present in the compound

Using coefficients

Consider: $NaNO_3$ (sodium nitrate)

- Formula indicates: 1-Na, 1-N, 3-O

Now consider: 4 $NaNO_3$

- Coefficient indicates 4 times as many of everything
- Therefore, 4-Na, 4-N, 12-O

How many atoms are indicated by the formula:

$Mg_3(PO_4)_2$

- 3-Mg, 2-P, 8-O

3 $Mg_3(PO_4)_2$

- Three times as many of everything
- 9-Mg, 6-P, 24-O

Some pointers in balancing

1. Only balance one element at a time
2. Use a pencil
   - easier to change coefficients as needed
3. Leave oxygen for last
4. Leave hydrogen for second to last

Some pointers in balancing

Reduce the coefficients if they can all be divided by the same number

Ex: $2\ P_4 + 10\ O_2 \rightarrow 4\ P_2O_5$

Coefficients should be divided by 2 and written

$P_4 + 5\ O_2 \rightarrow 2\ P_2O_5$