Chapter 6: Chemical Reactions, An Introduction

These Notes are to SUPPLIMENT the Text, They do NOT Replace reading the Text Material. Additional material that is in the Text will be on your tests! To get the most information, READ THE CHAPTER prior to the Lecture, bring in these lecture notes and make comments on these notes. These notes alone are NOT enough to pass any test!

The author is providing these notes as an addition to the students reading the text book and listening to the lecture. Although the author tries to keep errors to a minimum, the student is responsible for correcting any errors in these notes.

See Also my CHM 1045 Lecture Notes Ch 4 Chemical Reactions

Start Studying Ch7, Table 7.1 Solutilities

Chemistry is about change: Grass Grows, Iron Rusts, Car Engines burn gas, Blondes are Blondes.

What is the difference between a Chemical change and a Physical change?

Evidence for Chem Reaction. Chemical reactions often give a visual signal:

1. Color change
2. Solid forms [ppt, ↓]
3. Bubbles produced [↑]
4. Flame occurs

BUT - reactions are not always visible, some are, some are not!

HCl + Cobalt (II) Nitrate = turns blue or Rose in water

$HCl + Co(NO_3)_2 \rightarrow CoCl_2$ [Rose in Water] + HNO_3

Sodium Dichromate + Lead (II) Nitrate = a solid

$Na_2Cr_2O_7 + Pb(NO_3)_2 \rightarrow PbCr_2O_7 \downarrow + 2\ NaNO_3$

Calcium + water = bubbles of hydrogen

$Ca + 2\ H\text{-}OH \rightarrow Ca(OH)_2 + H_2 \uparrow$

Methane (or propane from your grill) + Oxygen = a flame

$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H\text{-}OH$

CHEMICAL REACTION is a Chemical Change

CHEMICAL EQUATION shows how a Chemical Reaction progresses

REACTANTS → PRODUCTS

Starting Material = REACTANTS → After the reaction has run = PRODUCTS

Chemical Reaction Properties

- In a Chemical Reaction, atoms are neither created nor destroyed - it changes the way atoms are grouped
- Atoms are conserved in a chemical reaction
- The identities (Formulas) of the compounds must never be changed in balancing a chemical equation
- The reaction is only a rearrangement of the way the atoms are grouped
- The same number of each type of atom is found in the reactants and products
  This is the Balancing the Equation
- The **Coefficient** represents a multiplier for the number of compounds in the reaction

Types of Equations describing a Chemical Reaction

1. Unbalanced Equation $HgO \rightarrow Hg + O_2 \uparrow$
2. Balanced Equation $2\ HgO \rightarrow 2\ Hg + O_2 \uparrow$
3. Balanced Ionic Equation
4. Net Ionic Equation

How do you do it:

1. Read the description of the reaction
   A. Write out the chemical formula for each of the reactants **See my notes on Ch 5**
   B. Write out the chemical formula for each of the reactants
2. Write the unbalanced equation
3. Balance the equation
4. Check the **coefficients** - count the atoms.

Balancing the Chemical Equation

All atoms present in the reactants must be accounted for in the products
The same number of each atom on the left as on the right side of the reaction

$CH_4 + O_2 \rightarrow CO_2 + H_2O$ One Carbon on the left and one on the right
Four Hydrogen's on the left, four on the right
Three Oxygen's on the left, three on the right

The **formula for a chemical reaction** provides us with

1. The identities of the reactants and the products
2. The relative numbers of each

Physical State **s** = solid or ↓ **g** = gas or ↑ **l** = liquid, **aq** = dissolved in water

$K_{(s)} + H_2O_{(l)} \rightarrow H_{2\,(g)} + KOH_{(aq)}$ = Unbalanced Equation

$H_{2\,(g)} + O_{2\,(g)} \rightarrow H_2O_{(g)}$ = Unbalanced Equation

Mercury (II) oxide → liquid mercury + oxygen gas

$HgO_{(s)} \rightarrow Hg_{(s)} + O_{2\,(g)}$

Solid Carbon reacts with Oxygen to form Carbon Dioxide

$C_{(s)} + O_{2\,(g)} \rightarrow CO_{2\,(g)}$

$Zinc_{(s)} + HCl_{aq} \rightarrow H_{2\,(g)} + ZnCl_{2\,(s)}$

$Mg_{(s)} + H_2O_{(l)} \rightarrow Mg(OH)_{2\,(s)} + H_{2\,(g)}$

Ammonium Dichromate (s) → Chromium (III) oxide + N_2 (gas) + H_2O(gas)

$(NH_4)_2 Cr_2O_{7\,(s)} \rightarrow Cr_2O_{3\,(s)} + N_{2\,(g)} + H_2O_{(g)}$

NH_3 (gas) + O_2 (gas) → Nitrogen Monoxide + H_2O (gas)

$NH_{3\,(g)} + O_{2\,(g)} \rightarrow NO_{(g)} + H_2O_{(g)}$

$2\ H_2O_2 \rightarrow 2\ H\text{-}OH + O_2 \uparrow$

- The identities (formula) of the compounds must never change in balancing a chemical equation
- The subscripts in a formula cannot be changed
- Most chemical equations can be balanced by trial and error

BOOK METHOD to balance an equation

$H_{2\,(g)} + O_{2\,(g)} \rightarrow H_2O_{(g)}$ unbalanced equation - need more O_2 on the right, so we add a H_2O

$H_2 + O_2 \rightarrow H_2O + H_2O$ now Hydrogen are unbalanced - add to left\

$H_2 + H_2 + O_2 \rightarrow H_2O + H_2O$ is the same as

➔ $2\ H_2 + O_2 \rightarrow 2\ H_2O$ [But this is more correct!!]

MY METHOD to balance an equation [Ping – Pong Method]

$H_{2\,(g)} + O_{2\,(g)} \rightarrow H_2O_{(g)}$

1. Pick one atom on the left, pick a Cation, pick the largest element

   I'll Pick $O_{2\,(g)}$

2. There is 1 Molecule of $O_{2\,(g)}$ on the left which equals 2 Oxygen on the left
3. Go to the right side. There is only 1 Oxygen. Make it 2 Oxygen

$H_{2\,(g)} + O_{2\,(g)} \rightarrow 2\ H_2O_{(g)}$

4. There is now 2 Oxygen on the right.
5. Look at the Element connected to the Oxygen. It is 2 H_2

   This is 4 Hydrogen on the right.

6. Go back to the LEFT side of the equation and look for the Hydrogen
7. There are only 2 Hydrogen on the left side, make it 4 by adding a 2

   $H_2 \rightarrow 2\ H_2$

$2\ H_{2\,(g)} + O_{2\,(g)} \rightarrow 2\ H_2O_{(g)}$

8. The equation is now balanced.

Or said another way, when an equation has a complicated molecule

1. Start with that one atom on one side. How many of this atom are there?
2. Look for that atom on the other side and add a coefficient to make the numbers the same
3. The look at what is attached to that atom and look for it on the other side.
4. Add a coefficient to make the numbers the same
5. Go back to step 3

The **CORRECT balanced equation** has the smallest integers (whole numbers) and are called the coefficients

Ethanol + $O_2 \rightarrow CO_2 + H_2O$ = $C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$

$K + H_2O \rightarrow H_2 + KOH$

$NH_3 + O_2$ [at 1000 ^oC] $\rightarrow NO_{(g)} + H_2O_{(g)}$

[Propane] $C_3H_8 + O_2 \text{->} CO_2 + H_2O$

Hydrofluoric acid + glass $\rightarrow$ Silicon Tetrafluoride + water [How you etch glass]
$HF + SiO_2 \rightarrow SiF_4 + H_2O$

Ammonium Nitrate $\rightarrow N_2 + O +$ water