

## Chapter 5

### Writing Balanced Chemical Equations Predicting Products of a Chemical Reaction.

#### 6:1,2,3 Chemical Reactions and Writing Balanced Chemical Equations. S 12 3 2

#### Chemical Equations:

Evidence for a chemical reaction

Parts of a chemical equation: Reactants  $\rightarrow$  Products ( $\rightarrow$ , yields or produces. Catalyst on arrow)

Law of Conservation of mass: *Atoms are neither created nor destroyed*, only rearranged. Balance of atoms.

Ex. 3.0 g of Na + 2.1 g S = 5.1 g of Na<sub>2</sub>S

\*Phase Notation: solid (s), if product ( $\downarrow$ ), (ppt.), precipitate

Liquid (l)

Gas (g), if product ( $\uparrow$ )

Dissolved in water (aq), aqueous

\*Write one phase for each pure substance. Do not indicate it for each element in a compound

Endothermic (+ $\Delta H$ , heat is a reactant) and exothermic (- $\Delta H$ , heat is a product).

Coefficients used to balance atoms. Ex. "3 Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> bookkeeping

Example: Photosynthesis  $6 \text{CO}_{2(g)} + 6 \text{O}_{2(g)} \text{-----} > \text{C}_6\text{H}_{12}\text{O}_{6(aq)} + 6 \text{H}_2\text{O}_{(l)}$

Show balance of reactants and product atoms as a bookkeeping table

**Assignment:** Write a balanced equation and structural (show atoms with balls) diagram equations for:

a.) 3 Cl<sub>2</sub>, 2 Fe, 5 H<sub>2</sub>O

b.) nitrogen and hydrogen make ammonia **Ex. on display screen**

c.) zinc and hydrochloric acid produces hydrogen gas and zinc chloride

d.) carbon reacts with oxygen to produce carbon dioxide

e.) sodium chloride is broken down into its elements

#### Guidelines for Balancing Chemical Equations by Inspection (Trial and Error):

1. Identify the reactants and products and write their correct chemical formulas. Write the unbalanced equation.
2. Balance most complex atoms first. Use coefficients only. Never change a formula's subscripts
3. Balance the polyatomic ions if they appear on both the reactant and product side.
4. Complete balancing of all other atoms. Usually H and O can be done last. They seem to balance themselves.
5. Reduce coefficients to simplest whole numbers

#### Homework Practice:

Worksheet

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#### Describing Reactions and Predicting the Products of Chemical Reactions

#### 5 Major Types of Chemical Reactions and Evidence of a Reaction:

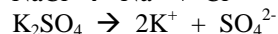
##### 1. Double Displacement Reactions (Metathesis): Chapter 7

2 compounds react by switching ions. Ionic charges do not change.

In general:  $AB + CD \rightarrow AD + BC$

3 Types of evidence: Formation of a **solid** precipitate, Neutralization produces **water**, formation of a **gas**.

Prelude: Anionic salt, when placed in water, dissociates "breaks up" into ions. A positive cation and a negative anion. Ex's. Write Products of Dissociation for the following salts:



### **Solubility Rules (distribute):** [Solubility Rules](#)

Decide if the following salts are soluble or insoluble in water:

#### A. Precipitation Reaction: formation of a solid precipitate:

*Introductory Discussion: (listen, don't worry about note taking.)*

Pure water does not conduct an electric current. A *non-electrolyte*. Demonstrate with conductivity apparatus. When ionic substances are placed in water they dissociate and as free ions would conduct an electric current, *electrolytes*. Most ionic materials only contain two types of ions. Ex. When ions of  $\text{AgNO}_3$  are placed in solution they appear as ( $\text{Ag}^+$  and  $\text{NO}_3^-$ ). In a separate beaker ions of  $\text{NaCl}$  appear as  $\text{Na}^+$  and  $\text{Cl}^-$ . If these 4 ions are mixed a solid precipitate is formed. What possible identity could the solid have? Rationalize with possibilities. Introduce Solubility Rules (P.183, Table 7.1 and back cover of textbook). Discuss **solubility rules handout** to distinguish soluble (disappears) Vs, Insoluble (remains undissolved) salts.

Write balanced equation with phase notation for reaction of silver nitrate and sodium chloride.

### **Net Ionic Equations**

#### B. Neutralization Reaction: Formation of water

Acids and bases neutralize to form salt and water. Acid + Base  $\rightarrow$  Ionic Salt and Water

Both are electrolytes. Net ionic:  $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$

	<b>Acids</b>	<b>Bases</b>
Taste	Sour	Bitter
Arrhenius	Produces $\text{H}^+$ (proton) in solution	Produces $\text{OH}^-$ (hydroxide ions) in solution
Ex.	$\text{HCl}$ , $\text{HNO}_3$ , $\text{H}_2\text{SO}_4$ , see ion sheet	$\text{NaOH}$ , $\text{KOH}$ , $\text{NH}_3$ , $\text{Ba}(\text{OH})_2$
Litmus	Red	Blue
pH	Below 7	Above 7

Ex. Reaction of hydrochloric acid and potassium hydroxide, with phase notation

Ex. Reaction of sulfuric acid and sodium hydroxide, with phase notation

#### C. Formation of a gas. Gas escapes as bubbles

Ex. Decomposition of carbonates:  $\text{PbCO}_{3(s)} \rightarrow \text{PbO}_{(s)} + \text{CO}_{2(g)}$

Ex. "Volcano";  $\text{HC}_2\text{H}_3\text{O}_{2(aq)} + \text{NaHCO}_{3(s)} \rightarrow \text{NaC}_2\text{H}_3\text{O}_{2(aq)} + \text{CO}_{2(g)} + \text{H}_2\text{O}_{(l)}$

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## **Chapter 8: Describing Reactions and Predicting the Products of Chemical Reactions**

### **Major Types of Chemical Reactions and Evidence of a Reaction:**

#### **B. Oxidation-Reduction Reactions** (Transfer of electrons. Oxidation numbers change) Chapter 8

- Recall that metals lose  $e^-$  (cation) and non-metals gain  $e^-$  (anion).
- Clues; Metal and Non-metal to produce an ionic compound, rusting, fuel burning, thermite!
- Review of periodic table: major trends of ions

Column I	Column II	Column III		Column VI	Column VII
Lose 1 electron	Lose 2 electrons	Lose 3 electrons		Gain 2 electrons	Gain 1 electron
$+1$ cation	$+2$ cation	$+3$ cation		$-2$ anion	$-1$ anion

2. **Synthesis (Combination):** 2 pure elements or small compounds that create a larger compound on the product side.

- Ex.  $2 \text{Na}_{(s)} + \text{Cl}_{2(g)} \rightarrow 2 \text{NaCl}_{(s)}$ , Uncharged neutral atoms develop a charge in compound.  
 Demo: Write for burning of magnesium ribbon with phase notation:  $\text{Mg}_{(s)} + \text{O}_{2(g)} \rightarrow \text{MgO}_{(s)}$
3. Decomposition (Analysis): A compound (never an element) is broken down into simpler substances, usually accomplished with heat or electric current.  
 Ex.  $2 \text{HgO}_{(s)} \rightarrow 2 \text{Hg}_{(l)} + \text{O}_{2(g)}$   
 Demo: Write for decomposition by heating of  $\text{KClO}_3$ .  $2 \text{KClO}_{3(s)} \rightarrow 2 \text{KCl}_{(s)} + 3 \text{O}_{2(g)}$
4. Combustion: Involve oxygen and produce heat so rapidly that a flame results.  
 Ex.  $\text{CH}_{4(g)} + 2 \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} + 2 \text{H}_2\text{O}_{(g)}$   
 Demo: Gummy Bear into the hot  $\text{KCl} / \text{O}_2$  from decomposition.  
 $\text{C}_6\text{H}_{12}\text{O}_6(s) + 6 \text{O}_{2(g)} \rightarrow 6 \text{CO}_{2(g)} + 6 \text{H}_2\text{O}_{(g)}$
5. Single Displacement Reaction: Element and compound combine. The element replaces the similar type of ion in the compound.  $\text{A} + \text{BC} \rightarrow \text{AC} + \text{B}$ , A and B are metals.  
 Ex.  $\text{Zn}_{(s)} + 2 \text{HCl}_{(aq)} \rightarrow \text{ZnCl}_{2(aq)} + \text{H}_{2(g)}$  With metal element as reactant  
 Ex.  $\text{F}_{2(g)} + \text{KCl}_{(aq)} \rightarrow \text{KF}_{(aq)} + \text{Cl}_{2(g)}$  With non-metal element as reactant  
 Demo: Write for Cu wire in solution of silver nitrate.  $\text{Cu}_{(s)} + \text{AgNO}_{3(aq)} \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{Ag}_{(s)}$
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### Laboratory: Writing Balanced Chemical Equations Based on Observations of Chemical Reactions

A series of different reactions are performed. The student must record all observations, classify the type of reaction, predict the products, and write a balanced equation with phase notation.  
 Eight different experiments are performed at each lab station.

### Comprehensive Review, Chapters 6,7, and 8

#### Mini-Lab, "The Four Bottle Experiment"

Mini-Lab, Identify the contents of a bottle from observations of reactions

Worksheet: Chemical Reactions and Equations. Concepts, Writing, and Overall Review.