Chemical Reactions Unit
Balance and Write Chemical Equations
Predict Products of Chemical Reactions
Overview

- the core of chemistry - how chemicals react with one another
Overview

Two parts:

1. **Language of chemical reactions**
   a) formulas (words/vocabulary) - from last unit
   b) chemical equations (sentences)
Overview

2. Different types of reactions
   a) classify
   b) predict products
   c) acids and bases, pH
Writing Chemical Equations

**Example:** Iron and chlorine gas react to produce the salt iron(III) chloride.

**Word equation:** describes the reaction in words, using equation symbols

\[ \text{Iron}(_\text{s}) + \text{chlorine}(_\text{g}) \rightarrow \text{iron (III) chloride}(_\text{s}) \]

**Skeleton formula equation:** describes the reaction using equation symbols and correct chemical formulas; unbalanced

\[ \text{Fe}(_\text{s}) + \text{Cl}_2(_\text{g}) \rightarrow \text{FeCl}_3(_\text{s}) \]
Writing Chemical Equations

Balanced formula equation: coefficients are used to equalize numbers of each atom on each side of the reaction

\[ 2 \text{Fe}(s) + 3 \text{Cl}_2(g) \rightarrow 2 \text{FeCl}_3(s) \]

**Iron** atoms on left \((2)\) \hspace{1cm} **iron** atoms on right \((2)\)

**Chlorine** atoms on left \((3 \times 2 = 6)\) \hspace{1cm} **chlorine** atoms on right \((2 \times 3 = 6)\)
Writing Chemical Equations

Total and net ionic equations: *describe the reaction using equation symbols and chemical formulas, shown as ions if the compound is aqueous (dissolved in water)* (10.3)
Steps for Writing and Balancing Chemical Equations

1. Write a **word equation** with the names for all **reactants** on the left and all **products** on the right:

   \[ \text{Reactants} \rightarrow \text{Products} \]

2. Convert the word equation to a **skeleton formula equation** by writing the correct **formulas** for all **reactants** and **products**. **Be sure that your formulas correctly represent the particles in the reaction!**

3. Use **coefficients** in front of formulas to **balance** the equation. **Do NOT** change the formulas!

4. Begin **balancing** with an element that occurs only once on each side of the arrow.
Steps for Writing and Balancing Chemical Equations

5. Multiply **coefficient** x **subscript** to determine the # of atoms of a specific element in one "term" of the equation:

   e.g. 4 H\textsubscript{2}O molecules:

   \[
   4 \times 2 = 8 \text{ H atoms} \quad 4 \times 1 = 4 \text{ O atoms}
   \]

6. Balance **one type of atom** at a time.

8. **Even/Odd rule**  

E.g. $\text{Fe} + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3$

Since the number of **oxygen** atoms on the **left** must always be **even**,

start by making the number of **oxygen** atoms on the **right** **even**, then balance the iron atoms.

$4 \text{ Fe} + 3 \text{ O}_2 \rightarrow 2 \text{ Fe}_2\text{O}_3$
9. Intact polyatomic ions

Fe + Pb\((C_2H_3O_2)_2\) → Fe\((C_2H_3O_2)_3\) + Pb

The acetate ion \((C_2H_3O_2)\) stays together as a group, so balance the ion as a group.

2 Fe + 3 Pb\((C_2H_3O_2)_2\) → 2 Fe\((C_2H_3O_2)_3\) + 3 Pb

One more reason it is useful to know your ions!
Balancing Hints

- Combustion reactions

We’ll focus on these at a later time.

Honors - check these hints out - two questions on WS #2
“yields” indicates the **products** of the reaction

Indicates a **reversible** reaction

A reactant or product in **aqueous** solution (dissolved in water)

A reactant or product in the **liquid** state

A reactant or product in the **solid** state

A reactant or product in the **gaseous** state

Reactants are **heated**

**Pressure** exceeding normal atmospheric pressure

**Temperature** at which reaction is carried out

Formula of **catalyst** used to alter the rate of the reaction
Practice - identify errors

For each of the following, explain why the equation is not properly balanced, then write the correctly balanced equation.

1. \[ \text{Mg(NO}_3\text{)}_2(\text{aq}) + 2 \text{K}_s(\text{s}) \rightarrow \text{Mg}_s(\text{s}) + \text{K}_2\text{NO}_6(\text{aq}) \]

2. \[ \text{AlCl}_3(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow \text{AgCl}_s(\text{s}) + \text{Al(NO}_3\text{)}_3(\text{aq}) \]
Practice - identify errors

For each of the following, explain why the equation is not properly balanced, then write the correctly balanced equation.

1. \( \text{Mg(NO}_3\text{)}_2(aq) + 2 \text{K(s) } \rightarrow \text{Mg(s)} + \text{K}_2\text{NO}_6(aq) \)

   Formula for KNO\(_3\) is not written correctly = 2 KNO\(_3\)

2. \( \text{AlCl}_3(aq) + \text{AgNO}_3(aq) \rightarrow \text{AgCl(s)} + \text{Al(NO}_3\text{)_3(aq)} \)

   Needs balancing \( \rightarrow 1, 3, 3, 1 \)
Practice - Writing and Balancing Chemical Equations (p. 4)

Write the **word equation**, **skeleton formula equation**, and **balanced formula equation** for each of the following reactions:

1. Solid magnesium metal and solid silver sulfide react to form solid magnesium sulfide and solid metallic silver.

2. Aqueous nitric acid and calcium hydroxide solutions react to form water and aqueous calcium nitrate

For each write the

**Word equation:**

**Skeleton formula equation:**

**Balanced Formula equation:**
1. Solid magnesium metal and solid silver sulfide react to form solid magnesium sulfide and solid metallic silver.

**Word equation:**

\[ \text{magnesium}_{(s)} + \text{silver sulfide}_{(s)} \rightarrow \text{magnesium sulfide}_{(s)} + \text{silver}_{(s)} \]

**Skeleton formula equation:**

\[ \text{Mg}_{(s)} + \text{Ag}_2\text{S}_{(s)} \rightarrow \text{MgS}_{(s)} + \text{Ag}_{(s)} \]

**Balanced Formula equation:**

\[ \text{Mg}_{(s)} + 2\text{Ag}_2\text{S}_{(s)} \rightarrow \text{MgS}_{(s)} + 2\text{Ag}_{(s)} \]
2. Aqueous nitric acid and calcium hydroxide solutions react to form water and aqueous calcium nitrate

**Word equation:**

\[
\text{nitric acid}_{(aq)} + \text{calcium hydroxide}_{(aq)} \rightarrow \text{water}_{(l)} + \text{calcium nitrate}_{(aq)}
\]

**Skeleton formula equation:**

\[
\text{HNO}_3_{(aq)} + \text{Ca(OH)}_2_{(aq)} \rightarrow \text{H}_2\text{O}_{(l)} + \text{Ca(NO}_3)_2_{(aq)}
\]

**Balanced Formula equation:**

\[
2 \text{HNO}_3_{(aq)} + \text{Ca(OH)}_2_{(aq)} \rightarrow 2 \text{H}_2\text{O}_{(l)} + \text{Ca(NO}_3)_2_{(aq)}
\]
3. Aluminum metal reacts with oxygen in the air to form aluminum oxide

4. When solid mercury (II) sulfide is heated with oxygen, liquid mercury metal and gaseous sulfur dioxide are produced

5. Oxygen gas can be made by heating potassium chlorate in the presence of the catalyst manganese dioxide. Potassium chloride is left as a solid residue.
3. Aluminum metal reacts with oxygen in the air to form aluminum oxide

Aluminum(s) + oxygen(g) → aluminum oxide(s)

\[ \text{Al}_{(s)} + \text{O}_{2(g)} \rightarrow \text{Al}_2\text{O}_3(s) \]

\[ 4 \text{Al}_{(s)} + 3 \text{O}_{2(g)} \rightarrow 2 \text{Al}_2\text{O}_3(s) \]
4. When solid mercury (II) sulfide is heated with oxygen, liquid mercury metal and gaseous sulfur dioxide are produced

\[
\text{mercury (II) sulfide}_{(s)} + \text{oxygen}_{(g)} \xrightarrow{\Delta} \text{mercury}_{(l)} + \text{sulfur dioxide}_{(g)}
\]

\[
\text{HgS}_{(s)} + \text{O}_{2(g)} \xrightarrow{\Delta} \text{Hg}_{(l)} + \text{SO}_{2(g)}
\]

\[
\text{HgS}_{(s)} + \text{O}_{2(g)} \rightarrow \text{Hg}_{(l)} + \text{SO}_{2(g)}
\]
5. Oxygen gas can be made by heating potassium chlorate in the presence of the catalyst manganese dioxide. Potassium chloride is left as a solid residue.

\[
\text{KClO}_3(s) \xrightarrow{\Delta, \text{MnO}_2} \text{KCl}(s) + \text{O}_2(g)
\]

\[
2 \text{KClO}_3(s) \rightarrow 2 \text{KCl}(s) + 3 \text{O}_2(g)
\]
Total and Net Ionic Equations
(Writing and Balancing Equations notes)

Dissolved potassium iodide and lead (II) nitrate react in aqueous solution
to produce solid lead (II) iodide and dissolved potassium nitrate

**Word equation:**

Potassium iodide\(_{(aq)}\) + lead (II) nitrate\(_{(aq)}\) \(\rightarrow\) lead (II) iodide\(_{(s)}\) + potassium nitrate\(_{(aq)}\)

**Formula (Skeleton) Equation**

\[ \text{KI\(_{(aq)}\) + Pb(NO}_3\text{)_2\(_{(aq)}\)} \rightarrow \text{PbI}_2\(_{(s)}\) + \text{KNO}_3\(_{(aq)}\) \]

**Balanced formula equation:**

\[ 2 \text{KI\(_{(aq)}\) + Pb(NO}_3\text{)_2\(_{(aq)}\)} \rightarrow \text{PbI}_2\(_{(s)}\) + 2 \text{KNO}_3\(_{(aq)}\) \]
Total and Net Ionic Equations

*Balanced formula equation:*

\[ 2 \text{KI}_\text{(aq)} + \text{Pb(NO}_3\text{)}_2\text{(aq)} \rightarrow \text{PbI}_2\text{(s)} + 2 \text{KNO}_3\text{(aq)} \]

*Total ionic equation.* Rewrite the equation so that all dissolved compounds (aq) (see solubility chart) are separated into their constituent ions:

\[ 2 \text{K}^+\text{(aq)} + 2 \text{I}^-\text{(aq)} + \text{Pb}^{2+}\text{(aq)} + 2 \text{NO}_3^-\text{(aq)} \rightarrow \text{PbI}_2\text{(s)} + 2 \text{K}^+\text{(aq)} + 2 \text{NO}_3^-\text{(aq)} \]

Spectator ions are those that appear on both sides of the equation and as such do not participate in the reaction. In the above example, the spectator ions are 2 \text{K}^+\text{(aq)} and 2 \text{NO}_3^-\text{(aq)}.

*Net ionic equation:*

Spectator ions cancel, and are *not* included in the net ionic equation:

\[ \text{Pb}^{2+}\text{(aq)} + 2 \text{I}^-\text{(aq)} \rightarrow \text{PbI}_2\text{(s)} \]
Net Ionic Equations
(p. 9 in Chem Rxns notes)

- Complete Balanced Equation:
  \[2 \text{KOH}_{(aq)} + \text{H}_{2}\text{SO}_{4(aq)} \rightarrow \text{K}_{2}\text{SO}_{4(aq)} + \text{H}_{2}\text{O}_{(l)}\]

- Total Ionic Equation:
  \[2 \text{K}^{+}_{(aq)} + 2 \text{OH}^{-}_{(aq)} + 2 \text{H}^{+}_{(aq)} + \text{SO}_{4}^{2-}_{(aq)} \rightarrow 2 \text{K}^{+}_{(aq)} + \text{SO}_{4}^{2-}_{(aq)} + 2 \text{H}_{2}\text{O}_{(l)}\]

- Net Ionic Equation:
  \[\text{OH}^{-}_{(aq)} + \text{H}^{+}_{(aq)} \rightarrow \text{H}_{2}\text{O}_{(l)}\]
Net Ionic Equations

1. What is a spectator ion?
2. What are the spectator ions in this reaction?
3. Compare and contrast each pair below.
   a. Complete balanced equations, total ionic equations
   b. Total ionic equations, net ionic equations
Net Ionic Equations

1. What is a spectator ion? An ion that does not participate in the reaction.
2. What are the spectator ions in this reaction? Na+, SO42-
3. Compare and contrast each pair below.
   a. Complete balanced equations, total ionic equations
   b. Total ionic equations, net ionic equations
Net Ionic Equations

4. For the reaction between aqueous silver nitrate and aqueous sodium chloride, write each of the following. The products of the reaction are aqueous sodium nitrate and solid silver chloride.
   a. complete balanced equation
   b. total ionic equation
   c. net ionic equation
Net Ionic Equations

5. What is the net ionic equation for the reaction between aqueous calcium hydroxide and nitric acid? The products of this reaction are aqueous calcium nitrate and water. How does this net ionic equation compare to the net ionic equation shown on the earlier slide?
Solubility Chart - used to predict the state of matter of products in DR reactions

S = soluble; P = slightly soluble; I = insoluble; D = decomposes in water; — = compound does not exist or is unstable.

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<th>Nonmetal</th>
<th>Acetate, C₂H₃O₂⁻</th>
<th>Bromide, Br⁻</th>
<th>Carbonate, CO₃²⁻</th>
<th>Chloride, Cl⁻</th>
<th>Chlorate, ClO₃⁻</th>
<th>Chromate, CrO₄²⁻</th>
<th>Hydroxide, OH⁻</th>
<th>Iodide, I⁻</th>
<th>Nitrate, NO₃⁻</th>
<th>Oxide, O²⁻</th>
<th>Oxalate, C₂O₄²⁻</th>
<th>Phosphate, PO₄³⁻</th>
<th>Silicate, SiO₃²⁻</th>
<th>Sulfate, SO₄²⁻</th>
<th>Sulfide, S²⁻</th>
<th>Sulfite, SO₃²⁻</th>
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* Certain salts occur in two modifications.
Warm up

1. Identify the reactants and products in the following word equations:
   
   a) Water decomposes to produce hydrogen and oxygen gases.
   
   b) Sodium chloride is produced when sodium metal reacts with chlorine gas.
   
   c) Methane gas reacts with oxygen gas to form carbon dioxide and water.

2. Briefly describe the differences between a, b and c (how the sentence is written) and how you identified the reactants and products.
Warm up

Write and balance the following reactions:

1. Aqueous solutions of silver nitrate and potassium iodide are mixed. Silver iodide and potassium nitrate are produced. Use your solubility chart to figure out which one is the precipitate.

2. When nitrogen dioxide is bubbled through water it produces nitric acid and nitrogen monoxide. What are the states of matter?
Warm up

Write and balance the following reactions:

- Aqueous solutions of silver nitrate and potassium iodide are mixed. Silver iodide and potassium nitrate are produced. Use your solubility chart to figure out which one is the precipitate.

\[
\text{silver nitrate(aq) + potassium iodide(aq) \rightarrow silver iodide + potassium nitrate}
\]

\[
\text{AgNO}_3(aq) + KI(aq) \rightarrow \text{AgI}(s) + KNO_3(aq)
\]
Warm up

Write and balance the following reactions:

2. When nitrogen dioxide is bubbled through water it produces nitric acid and nitrogen monoxide. What are the states of matter of nitrogen dioxide, nitric acid and nitrogen monoxide?

Nitrogen dioxide + water(l) $\rightarrow$ nitric acid + nitrogen monoxide

Nitrogen dioxide(g) + water(l) $\rightarrow$ nitric acid(aq) + nitrogen monoxide(g)

$\text{NO}_2(g) + \text{H}_2\text{O}(l) \rightarrow \text{HNO}_3(aq) + \text{NO}(g)$

$3 \text{NO}_2(g) + \text{H}_2\text{O}(l) \rightarrow 2 \text{HNO}_3(aq) + \text{NO}(g)$
Evidence of a Chemical Reaction
(Chemical Reactions notes)

<table>
<thead>
<tr>
<th>Observation</th>
<th>What it means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bubbles, inflates bag, disappears, steam, smell, smoke</td>
<td><strong>Gas</strong> Formation/Release</td>
</tr>
<tr>
<td>Clear to cloudy, solid appears on bottom</td>
<td><strong>Precipitate</strong> (solid) Formation</td>
</tr>
<tr>
<td>Flame, light, temperature change</td>
<td>Change in <strong>energy</strong></td>
</tr>
<tr>
<td>Color change</td>
<td>Color change, e.g. acid/base <strong>indicator</strong></td>
</tr>
</tbody>
</table>

We can only know the products of a chemical reaction by carrying out the reaction in the laboratory, BUT, we can make **general predictions** about the products of a reaction based on “types” of chemical reactions.
Types of Chemical Reactions
(not all reactions fit these categories)

1. Synthesis (or Combination)
2. Decomposition
3. Single Replacement
4. Double Replacement (or Metathesis)
5. Combustion

6. Oxidation-Reduction (Redox) (Honors)
1. Exothermic Reaction

Releases energy (energy = one of the products)

\[ \text{C} \,(s) \, + \, \text{O}_2(g) \rightarrow \text{CO}_2(g) \, + \, 393.5 \, \text{kJ} \quad \Delta H = -393.5 \, \text{kJ} \]
Energy Changes in Chemical Reactions

1. Endothermic Reaction

absorbs energy (energy = one of the reactants)

\[
\text{CaCO}_3(s) + 176 \text{ kJ} \rightarrow \text{CaO}(s) + \text{CO}_2(g) \quad \Delta H = +176 \text{ kJ}
\]
Synthesis (combination)

A + B → AB (one product)
usually produces energy – exothermic

Examples:

metal + nonmetal (often oxygen)

Cu + O₂ → Cu₂O
Cu + O₂ → CuO
Na + Br₂ → NaBr

metal oxide + water → base

MgO + H₂O → Mg(OH)₂

(Honors)

nonmetal + nonmetal

N₂ + O₂ → NO₂
SO₂ + O₂ → SO₃

nonmetal oxide + water → acid

CO₂ + H₂O → H₂CO₃

(Honors)
Synthesis reactions are usually Exothermic

Releases energy (energy is a product)

\[ \text{C}_\text{(s)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)} + 393.5 \text{ kJ} \quad \Delta H = -393.5 \text{ kJ} \]
Decomposition

\[ AB \xrightarrow{\Delta \text{ or } \not\rightleftharpoons \text{ or light}} A + B \]  
(one reactant, > 1 product)

usually \textbf{requires} energy - endothermic

**Examples**

**Compound**

\[ \Delta \]

\[ \text{2 elements} \]

\[ \text{Ag}_2\text{O} \rightarrow \text{Ag} + \text{O}_2 \]

**Reactant**

\[ \not\rightleftharpoons \]

\[ \text{2 elements (electrolysis)} \]

\[ \text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}_2 \]

**Metal carbonate**

\[ \Delta \]

\[ \text{metal oxide + carbon dioxide (Honors)} \]

\[ \text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2 \]

**Acid**

\[ \Delta \]

\[ \text{nonmetal oxide + water (Honors)} \]

\[ \text{H}_2\text{CO}_3 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]
Decomposition reactions are usually Endothermic
Absorbs energy (energy is a reactant)

\[
\text{CaCO}_3(s) + 176 \text{kJ} \rightarrow \text{CaO}(s) + \text{CO}_2(g) \quad \Delta H = +176 \text{kJ}
\]
Warmup

- Write balanced chemical equations for the following synthesis and decomposition chemical reactions.
- Figure out what the states of matter should be at room temperature.
- Predict products according to the type of reaction.
Warmup

Synthesis:
1. carbon + oxygen →
2. gallium + oxygen →
3. nitrogen + hydrogen →
4. phosphorus (V) oxide + water →
5. calcium oxide + water →
Warmup

Synthesis:

1. carbon + oxygen \rightarrow
   \[ C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \]
   or \[ 2 C_{(s)} + O_{2(g)} \rightarrow 2 CO_{(g)} \]

2. gallium + oxygen \rightarrow
   \[ 4 Ga_{(s)} + 3 O_{2(g)} \rightarrow 2 Ga_{2}O_{3(s)} \]

3. nitrogen + hydrogen \rightarrow
   \[ N_{2(g)} + 3 H_{2(g)} \rightarrow 2 NH_{3(g)} \]
Synthesis:

(H) 4. phosphorus (V) oxide + water →
   \[ P_2O_5(s) + 3 \text{H}_2\text{O}(l) \rightarrow 2 \text{H}_3\text{PO}_4(aq) \]

(H) 5. calcium oxide + water →
   \[ \text{CaO}(s) + \text{H}_2\text{O}(l) \rightarrow \text{Ca(OH)}_2(s) \]
Warmup

Decomposition:
1. sodium oxide →
2. aluminum chloride →

(H) 3. calcium carbonate →
(H) 4. potassium chlorate →
Warmup

Decomposition:

1. sodium oxide $\rightarrow$
   \[
   2 \text{Na}_2\text{O}(s) \rightarrow 4 \text{Na}(s) + \text{O}_2(g)
   \]

2. aluminum chloride $\rightarrow$
   \[
   2 \text{AlCl}_3(s) \rightarrow 2 \text{Al}(s) + 3 \text{Cl}_2(g)
   \]
Warmup

Decomposition:
(H) 3. calcium carbonate $\rightarrow$

$$\Delta$$

$$\text{CaCO}_3(s) \rightarrow \text{CaO}(s) + \text{CO}_2(g)$$

(H) 4. potassium chlorate $\rightarrow$

$$2 \text{KClO}_3(s) \rightarrow 2 \text{KCl}(s) + 3 \text{O}_2(g)$$
Single Replacement

\[ A + BX \rightarrow AX + B \]

Use activity series to predict – higher replaces lower

**Cation Replacement**

Metal replaces Metal

\[ \text{Mg}^{(s)} + \text{SnCl}_2^{(aq)} \rightarrow \text{MgCl}_2^{(aq)} + \text{Sn}^{(s)} \]

**Metal replaces H in an acid**

\[ \text{Fe}^{(s)} + \text{H}_2\text{SO}_4^{(aq)} \rightarrow \text{FeSO}_4^{(aq)} + \text{H}_2^{(g)} \]

**Anion replacement**

Halogen replaces Halogen

\[ \text{Br}_2^{(l)} + \text{SrI}_2^{(aq)} \rightarrow \text{SrBr}_2^{(aq)} + \text{I}_2^{(s)} \]
Activity Series (tt34, 10.2)
Used to predict Single Replacement Reactions

<table>
<thead>
<tr>
<th>Metal</th>
<th>Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium</td>
<td>All replace the hydrogen in water and acids.</td>
</tr>
<tr>
<td>Rubidium</td>
<td>Each replaces metals listed below it.</td>
</tr>
<tr>
<td>Potassium</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>All replace the hydrogen in acids.</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Each replaces metals listed below it.</td>
</tr>
<tr>
<td>Manganese</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td></td>
</tr>
<tr>
<td>Tin</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>All are mostly unreactive as far as replacing other metals in a compound.</td>
</tr>
<tr>
<td>Silver</td>
<td></td>
</tr>
<tr>
<td>Platinum</td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Halogen</th>
<th>Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorine</td>
<td>Each replaces halogens listed below it.</td>
</tr>
<tr>
<td>Chlorine</td>
<td></td>
</tr>
<tr>
<td>Bromine</td>
<td></td>
</tr>
<tr>
<td>Iodine</td>
<td></td>
</tr>
</tbody>
</table>

See your reference sheet
Demonstration - Single Replacement Reaction

- Use the activity series on your reference sheet to predict the products of the following reactions:

- \( \text{Cu}_\text{(s)} + \text{AgNO}_3\text{(aq)} \rightarrow \)

- \( \text{Ag}_\text{(s)} + \text{Cu(NO}_3\text{)}_2\text{(aq)} \rightarrow \)

- During the demo, record your observations
The Activity Series

1. For each of the following pairs of elements, circle the one that would replace the other element in a compound.
   a. calcium, tin
   b. bromine, fluorine
   c. aluminum, potassium
   d. zinc, calcium
   e. iron, copper
   f. iodine, chlorine
   g. silver, lead
The Activity Series

1. For each of the following pairs of elements, circle the one that would replace the other element in a compound.

   a. calcium, tin  
   b. bromine, fluorine  
   c. aluminum, potassium  
   d. zinc, calcium  
   e. iron, copper  
   f. iodine, chlorine  
   g. silver, lead
The Activity Series

2. For each of the following reactants, use the activity series to determine whether the reaction would take place or not. If no reaction takes place, write NR in the blank. If a reaction does take place, write the formulas for the products of the reaction. (Hint: If an active metal replaces the hydrogen in water, the hydroxide of the active metal forms. H-OH)

a. \( \text{Li}_\text{(s)} + \text{Fe(NO}_3\text{)}_3\text{(aq)} \rightarrow \) ________

b. \( \text{Au}_\text{(s)} + \text{HCl}_\text{(aq)} \rightarrow \) ________

c. \( \text{Cl}_2\text{(g)} + \text{KBr}_\text{(aq)} \rightarrow \) ________

d. \( \text{Cu}_\text{(s)} + \text{Al(NO}_3\text{)}_3\text{(aq)} \rightarrow \) ________

e. \( \text{Ag}_\text{(s)} + \text{HBr}_\text{(aq)} \rightarrow \) ________

f. \( \text{Ni}_\text{(s)} + \text{SnCl}_2\text{(aq)} \rightarrow \) ____________
The Activity Series

2. For each of the following reactants, use the activity series to determine whether the reaction would take place or not. If no reaction takes place, write NR in the blank. If a reaction does take place, write the formulas for the products of the reaction. (Hint: If an active metal replaces the hydrogen in water, the hydroxide of the active metal forms.)

a. $3 \text{Li}_\text{s} + \text{Fe(NO}_3\text{)}_3\text{aq} \rightarrow 3 \text{LiNO}_3\text{aq} + \text{Fe}_\text{s}$
b. $\text{Au}_\text{s} + \text{HCl}_\text{aq} \rightarrow \text{NR}$
c. $\text{Cl}_2\text{g} + 2 \text{KBr}_\text{aq} \rightarrow 2 \text{KCl}_\text{aq} + \text{Br}_2\text{l}$
d. $\text{Cu}_\text{s} + \text{Al(NO}_3\text{)}_3\text{aq} \rightarrow \text{NR}$
e. $\text{Ag}_\text{s} + \text{HBr}_\text{aq} \rightarrow \text{NR}$
f. $\text{Ni}_\text{s} + \text{SnCl}_2\text{aq} \rightarrow \text{Sn}_\text{s} + \text{NiCl}_2\text{aq}$
3. **Magnesium metal can be used to remove tarnish from silver items.** Silver tarnish is the corrosion that occurs when silver metal reacts with substances in the environment, especially those containing sulfur. Why would magnesium remove tarnish from silver?
The Activity Series

3. Magnesium metal can be used to remove tarnish from silver items. Silver tarnish is the corrosion that occurs when silver metal reacts with substances in the environment, especially those containing sulfur. Why would magnesium remove tarnish from silver?

Mg is more active than Ag and will replace it in Ag compounds, restoring the Ag metal.
The Activity Series

4. Use the activity series for metals to explain why copper metal is used in plumbing where the water might contain compounds of many different metals.
4. Use the activity series for metals to explain why copper metal is used in plumbing where the water might contain compounds of many different metals.

Cu is not an active metal, compared with the metals dissolved in water such as Ca$^{2+}$ and Mg$^{2+}$. It does not replace these metals in the compounds dissolved in water. The Cu pipes remain intact.
The Activity Series

5. The last four metals in the activity series of metals are commonly referred to as the “coinage metals”. Why would these metals be chosen over more active metals for use in coins? Why do you think some more active metals, such as zinc or nickel, are sometimes used in coins?
The Activity Series

5. The last four metals in the activity series of metals are commonly referred to as the “coinage metals”. Why would these metals be chosen over more active metals for use in coins? Why do you think some more active metals, such as zinc or nickel, are sometimes used in coins?

Cu, Ag, Pt and Au would be more durable because they will not react as readily with substances in the environment. However, the more active metals, such as Ni and Zn are somewhat durable and cost much less.
Double Replacement

\[ AX_{(aq)} + BY_{(aq)} \rightarrow AY_{(aq)} + BX_{(s, g \text{ or } l)} \]

If both products are aqueous, NR

Use solubility table to predict

Precipitate-forming (s)

\[ \text{Pb(NO}_3\text{)}_2(aq) + \text{KI}_{(aq)} \rightarrow \text{KNO}_3(aq) + \text{PbI}_2(s) \]

Gas-forming (g) (e.g. CO\textsubscript{2} from a 2\textdegree \text{ decomposition rxn})

\[ \text{NaHCO}_3(aq) + \text{H}_2\text{C}_2\text{H}_3\text{O}_2(aq) \rightarrow \text{NaC}_2\text{H}_3\text{O}_2(aq) + \text{H}_2\text{O}(l) + \text{CO}_2(g) \]

Water-forming (l)

\[ \text{H}_2\text{SO}_4(aq) + \text{NaOH}_{(aq)} \rightarrow \text{Na}_2\text{SO}_4(aq) + \text{HOH}(l) \]

acid $+$ base $\rightarrow$ salt $+$ water
Solubility Chart - used to predict the state of matter of products in DR reactions

$S = $ soluble; $P = $ slightly soluble; $I = $ insoluble; $D = $ decomposes in water; $-$ = compound does not exist or is unstable.

Aluminum acetate vs. aluminum hydroxide
Use the activity series or solubility table to predict the product of the following reactions:

\[ \text{Na}_\text{(s)} + \text{SrBr}_2\text{(aq)} \rightarrow \]

\[ \text{CrI}_3\text{(aq)} + \text{KCl}_\text{(aq)} \rightarrow \]

\[ \text{Zn}_\text{(s)} + \text{H}_2\text{SO}_3\text{(aq)} \rightarrow \]

\[ \text{K}_2\text{CO}_3\text{(aq)} + \text{HI}_\text{(aq)} \rightarrow \]
Warm Up - SR and DR

Use the activity series or solubility table to predict the product of the following reactions:

\[ 2 \text{Na}_\text{(s)} + \text{SrBr}_2\text{(aq)} \rightarrow \text{NR} \]

\[ \text{CrI}_3\text{(aq)} + 3 \text{KCl}_\text{(aq)} \rightarrow \text{CrCl}_3\text{(s)} + 3 \text{KI}_\text{(aq)} \text{ (DR - ppt)} \]

\[ \text{Zn}_\text{(s)} + \text{H}_2\text{SO}_3\text{(aq)} \rightarrow \text{ZnSO}_3\text{(aq)} + \text{H}_2\text{(g)} \text{ (SR - metal + acid)} \]

\[ \text{K}_2\text{CO}_3\text{(aq)} + 2 \text{HI}_\text{(aq)} \rightarrow 2 \text{KI}_\text{(aq)} + \text{H}_2\text{CO}_3\text{(aq)} \text{ (DR - gas)} \]

\[ \text{H}_2\text{O}_\text{(l)} + \text{CO}_2\text{(g)} \]
Use the activity series or solubility table to predict the product of the following reactions:

\[ \text{Na}_\text{s} + \text{H}_2\text{O}_\text{l} \rightarrow \]

\[ \text{HC}_2\text{H}_3\text{O}_2\text{(aq)} + (\text{NH}_4)_2\text{S}_\text{(aq)} \rightarrow \]

\[ \text{Fe}_\text{s} + \text{CuCl}_2\text{(aq)} \rightarrow \]

\[ \text{HBr}_\text{(aq)} + \text{Ba(OH)}_2\text{(aq)} \rightarrow \]
Warm Up – SR and DR

Use the activity series or solubility table to predict the product of the following reactions:

\[ 2 \text{Na}_\text{(s)} + 2 \text{H}_2\text{O}_{\text{(l)}} \rightarrow 2 \text{NaOH}_{\text{(aq)}} + \text{H}_2\text{(g)} \quad \text{(SR - metal + H}_2\text{O)} \]

\[ 2 \text{HC}_2\text{H}_3\text{O}_2_{\text{(aq)}} + (\text{NH}_4\text{)}_2\text{S}_{\text{(aq)}} \rightarrow \text{H}_2\text{S}_{\text{(g)}} + 2 \text{NH}_4\text{C}_2\text{H}_3\text{O}_2_{\text{(aq)}} \quad \text{(DR - gas)} \]

\[ \text{Fe}_\text{(s)} + \text{CuCl}_2_{\text{(aq)}} \rightarrow \text{Cu}_\text{(s)} + \text{FeCl}_2_{\text{(aq)}} \quad \text{(SR - metal/metal)} \]

\[ 2 \text{HBr}_{\text{(aq)}} + \text{Ba(OH)}_2_{\text{(aq)}} \rightarrow \text{BaBr}_2_{\text{(aq)}} + 2 \text{H}_2\text{O}_{\text{(l)}} \quad \text{(DR - acid-base neutralization)} \]
5. Combustion

Hydrocarbon + O₂ → CO₂ + H₂O + energy

*complete* - forms CO₂ + H₂O

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

*incomplete* - forms CO + H₂O + energy

\[ \text{CH}_4 + \text{O}_2 \rightarrow \text{CO} + \text{H}_2\text{O} + \text{energy} \]
Combustion reactions

e.g. \( \text{C}_2\text{H}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \)

1. Balance **hydrogens**, but at the same time make the number of **oxygens** in \( \text{H}_2\text{O} \) even by doubling the coefficient if necessary - do NOT balance the oxygens at this point!

   (i.e. make the number of Hs in the reactants divisible by 4)

   \[
   \begin{align*}
   \text{C}_2\text{H}_2 + \text{O}_2 & \rightarrow \text{CO}_2 + \text{H}_2\text{O} \\
   2 \text{C}_2\text{H}_2 + \text{O}_2 & \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}
   \end{align*}
   \]

2. Balance **carbons**

   \[
   \begin{align*}
   2 \text{C}_2\text{H}_2 + \text{O}_2 & \rightarrow 4 \text{CO}_2 + 2 \text{H}_2\text{O}
   \end{align*}
   \]

3. Lastly, balance the **oxygen molecules** on the left

   \[
   \begin{align*}
   2 \text{C}_2\text{H}_2 + 5 \text{O}_2 & \rightarrow 4 \text{CO}_2 + 2 \text{H}_2\text{O} \\
   2 \text{C}_2\text{H}_2 + 5 \text{O}_2 & \rightarrow 4 \text{CO}_2 + 2 \text{H}_2\text{O}
   \end{align*}
   \]
Balance Combustion Reactions

1. Is # of H in hydrocarbon divisible by 4?
   a) If yes, hydrocarbon coefficient = 1
   b) If no, hydrocarbon coefficient = 2

2. Balance hydrogen

3. Balance carbon

4. Balance oxygen LAST

Balance the following complete combustion reactions:

\[ \underline{\_} \text{C}_3\text{H}_8(\text{g}) + \underline{\_} \text{O}_2(\text{g}) \rightarrow \underline{\_} \text{CO}_2(\text{g}) + \underline{\_} \text{H}_2\text{O}(\text{g}) \]

\[ \underline{\_} \text{C}_5\text{H}_{12}(\text{g}) + \underline{\_} \text{O}_2(\text{g}) \rightarrow \underline{\_} \text{CO}_2(\text{g}) + \underline{\_} \text{H}_2\text{O}(\text{g}) \]
Balance Combustion Reactions

Now balance the chemical reactions for the complete combustion of hexane (C$_6$H$_{14}$) and decane (C$_{10}$H$_{22}$):

$$\underline{\_\_\_} \text{C}_6\text{H}_{14}(g) + \underline{\_\_\_} \text{O}_2(g) \rightarrow \underline{\_\_\_} \text{CO}_2(g) + \underline{\_\_\_} \text{H}_2\text{O}(g)$$

$$\underline{\_\_\_} \text{C}_{10}\text{H}_{22}(g) + \underline{\_\_\_} \text{O}_2(g) \rightarrow \underline{\_\_\_} \text{CO}_2(g) + \underline{\_\_\_} \text{H}_2\text{O}(g)$$
Combustion Practice  
(p. 8 of Chem Rxns notes)

Write balanced chemical equations for the complete combustion of 

- **propane (C₃H₈)**
  
  \[
  \begin{align*}
  C_3H_8(g) + \text{O}_2(g) &\rightarrow CO_2(g) + H_2O(g) + \text{heat} \\
  C_3H_8(g) + \text{O}_2(g) &\rightarrow CO_2(g) + 4H_2O(g) + \text{heat} \\
  C_3H_8(g) + \text{O}_2(g) &\rightarrow 3CO_2(g) + 4H_2O(g) + \text{heat} \\
  C_3H_8(g) + 5\text{O}_2(g) &\rightarrow 3CO_2(g) + 4H_2O(g) + \text{heat}
  \end{align*}
  \]
Combustion Practice
(p. 8 of Chem Rxns notes)

Write balanced chemical equations for the complete combustion of

- decane (C_{10}H_{22})

\[ C_{10}H_{22}(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g) + \text{heat} \]

\[ 2 \ C_{10}H_{22}(g) + O_2(g) \rightarrow CO_2(g) + 22 \ H_2O(g) + \text{heat} \]

\[ 2 \ C_{10}H_{22}(g) + O_2(g) \rightarrow 20 \ CO_2(g) + 22 \ H_2O(g) + \text{heat} \]

\[ 2 \ C_{10}H_{22}(g) + 31 \ O_2(g) \rightarrow 20 \ CO_2(g) + 22 \ H_2O(g) + \text{heat} \]
Write balanced chemical equations for the complete combustion of

- Ethyl alcohol (C₂H₅OH) - note the single O

\[ \text{C}_2\text{H}_5\text{OH}(l) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g) + \text{heat} \]

\[ \text{C}_2\text{H}_5\text{OH}(l) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + 3 \text{H}_2\text{O}(g) + \text{heat} \]

\[ \text{C}_2\text{H}_5\text{OH}(l) + \text{O}_2(g) \rightarrow 2 \text{CO}_2(g) + 3 \text{H}_2\text{O}(g) + \text{heat} \]

\[ \text{C}_2\text{H}_5\text{OH}(l) + 3 \text{O}_2(g) \rightarrow 2 \text{CO}_2(g) + 3 \text{H}_2\text{O}(g) + \text{heat} \]
Redox Reactions

Electrons are transferred from one atom to another.

- **Oxidation** = - electrons from a substance
- **Reduction** = + electrons to a substance

\[ \text{Mg} \text{(s)} + 2 \text{HCl}\text{(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)} \]

\[
\begin{array}{c|c|c|c}
\text{Mg} & 0 & +1 & -1 \\
\text{HCl} & +2 & -1 & 0 \\
\text{MgCl}_2 & & & \\
\text{H}_2 & & & 0 \\
\end{array}
\]

- **Note:** The transfer of electrons during oxidation-reduction reactions often produce energy (when spontaneous), which can be in the form of electricity.
Oxidation-Reduction Reactions

Mnemonics to help remember which is which:

- LEO the lion says GER  (Loss of Electrons = Oxidation/Gain of Electrons = Reduction)
- OIL RIG  (oxidation is loss and reduction is gain)
Upcoming Lab Quiz

With the help of your lab notebook, you will be expected to:

1. Write balanced chemical equations for reactions at all lab stations
2. Identify the type of reaction at each station
3. Provide safety information
4. Provide information regarding the various tests you performed at each station
5. Answer extension-type questions about each station, including writing equations for similar reactions.
Intro to Chemical Reactions Lab

Prepare lab notebook for this lab:

- Read the first page of the instructions carefully before you begin

Include:

- Overall purpose

- List of materials and flowchart for each of the 8 stations (recommendation is 1 station per page) - minimum of 4 for Th/F

- Include safety information and notes to yourself in your flowchart - see Flinn Scientific catalog, first section, on lab benches

- Check out the lab setups themselves

- Note checklists for each station (in the instructions) - use these to help you prepare your lab notebook so that you can focus on the lab itself
Intro to Chemical Reactions Lab
Add the following info to your lab notebook

- Splint test:
  - flame goes out: carbon dioxide
  - flame flares up: oxygen
  - “pop” and flame goes out: hydrogen
Intro to Chemical Reactions Lab

- Full lab gear - apron and goggles
- Complete the experiment - observations, reaction predictions, etc. at each station before you continue to another station
- When finished, begin working on WSs
Redox Reactions

Examples:
a) Combustion: “rapid oxidation reaction in which a large amount of heat and usually light are released”

\[ C + O_2 \rightarrow CO_2, CO \]
\[ S + O_2 \rightarrow SO_2 \]

What was oxidized?
What was reduced?
Redox Reactions

Examples:

b) Metal + acid (SR)

\[ \text{Zn} (s) + 2 \text{HCl} (aq) \rightarrow \text{ZnCl}_2(aq) + \text{H}_2(g) \]

Total ionic equation:

What was oxidized?
What was reduced?
Redox Reactions

Examples:

b) Metal + acid (SR)

\[ \text{Zn}_{(s)} + 2 \text{HCl}_{(aq)} \rightarrow \text{ZnCl}_2_{(aq)} + \text{H}_2_{(g)} \]

Total ionic equation:
Net ionic equation:

What was oxidized?
What was reduced?

Half-reactions:
Redox Reactions

Examples:

\[ \text{Metal} + \text{salt (SR)} \]

\[ \text{Mg}_{(s)} + \text{CoSO}_4_{(aq)} \rightarrow \text{MgSO}_4_{(aq)} + \text{Co}_{(s)} \]

Total ionic equation:

What was oxidized? What was reduced?
Oxidation Numbers

- help us keep track of what happens to the electrons in reactions
Oxidation Numbers

Rules:
1. Elemental form - oxidation number = 0
2. Monatomic ion - oxidation number = charge on the ion
3. Nonmetals - usually have negative oxidation numbers
   a) Oxygen - usually -2 (exception is peroxide ion, oxygen has oxidation number of -1)
   b) Hydrogen - +1 when bonded to nonmetals, -1 when bonded to metals
   c) Fluorine - -1 in all compounds (why?)
      Other halogens - -1 in most situations, positive when combined with oxygen (e.g. oxyanions)
   d) Sum of oxidation numbers of all atoms in a neutral compound = 0
      Sum of oxidation numbers in a polyatomic ion = charge on the ion
Write total and net ionic equations for the following reactions. Identify the redox pairs. Label oxidation numbers.

\[
2 \text{Na}_\text{(s)} + \text{SrBr}_2\text{(aq)} \rightarrow \text{Sr}_\text{(s)} + 2 \text{NaBr}_\text{(aq)}
\]

\[
\text{Zn}_\text{(s)} + \text{H}_2\text{SO}_3\text{(aq)} \rightarrow \text{ZnSO}_3\text{(s)} + \text{H}_2(\text{g})
\]

\[
2 \text{Na}_\text{(s)} + 2 \text{H}_2\text{O}_\text{(l)} \rightarrow 2 \text{NaOH}_\text{(aq)} + \text{H}_2(\text{g})
\]

\[
\text{Fe}_\text{(s)} + \text{CuCl}_2\text{(aq)} \rightarrow \text{Cu}_\text{(s)} + \text{FeCl}_2\text{(aq)}
\]
Warm Up

Label redox pairs and oxidation numbers:

\[2 \text{ Na}_{(s)} + \text{ SrBr}_2_{(aq)} \rightarrow \text{ NR}\]

\[\text{Zn}_{(s)} + \text{ H}_2\text{SO}_3_{(aq)} \rightarrow \text{ ZnSO}_3_{(aq)} + \text{ H}_2_{(g)}\]

\[\begin{array}{cccc}
0 & 2 \times 1^+ & 2^+ & 0 \\
\end{array}\]

\text{Zn} \text{ is oxidized: } \text{Zn} \rightarrow \text{Zn}^{2+}, \; \text{H}^+ \text{ is reduced } \rightarrow \text{H}_2
Warm Up

Label redox pairs and oxidation numbers:

\[ 2 \text{Na}_\text{(s)} + 2 \text{H}_2\text{O}_\text{(l)} \rightarrow 2 \text{NaOH}_\text{(aq)} + \text{H}_2\text{(g)} \]

<table>
<thead>
<tr>
<th>Element</th>
<th>Oxidation Number</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>O</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>H</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Na is oxidized: \( \text{Na} \rightarrow \text{Na}^+ \), \( \text{H}^+ \) is reduced \( \rightarrow \text{H}_2 \)

\[ \text{Fe}_\text{(s)} + \text{CuCl}_2\text{(aq)} \rightarrow \text{Cu}_\text{(s)} + \text{FeCl}_2\text{(aq)} \]

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<td>Fe</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cu</td>
<td>2+</td>
<td>No change</td>
</tr>
</tbody>
</table>

Fe is oxidized: \( \text{Fe} \rightarrow \text{Fe}^{2+} \), \( \text{Cu}^{2+} \) is reduced \( \rightarrow \text{Cu} \)
## Predicting Products

<table>
<thead>
<tr>
<th>Class of Reaction</th>
<th>Reactants</th>
<th>Probable Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthesis</td>
<td>two or more substances</td>
<td></td>
</tr>
<tr>
<td>Decomposition</td>
<td>one compound</td>
<td></td>
</tr>
<tr>
<td>Single Replacement</td>
<td>a metal and a compound</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a nonmetal (halogen) and a compound</td>
<td></td>
</tr>
<tr>
<td>Double Replacement (metathesis)</td>
<td>two compounds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dissolved in water</td>
<td></td>
</tr>
<tr>
<td>Combustion (restricted definition)</td>
<td>hydrocarbon + oxygen</td>
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# Predicting Products

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<td>two or more elements or compounds</td>
</tr>
<tr>
<td>Single Replacement</td>
<td>a metal and a compound, a nonmetal (halogen), and a compound</td>
<td>a new compound and the replaced metal or hydrogen, a new compound and the replaced nonmetal (halogen)</td>
</tr>
<tr>
<td>Double Replacement (metathesis)</td>
<td>two compounds dissolved in water</td>
<td>two different compounds, one of which is a solid, water, or a gas</td>
</tr>
<tr>
<td>Combustion (restricted definition)</td>
<td>hydrocarbon + oxygen</td>
<td>carbon dioxide (or carbon monoxide) and water</td>
</tr>
<tr>
<td>Oxidation-Reduction (Honors)</td>
<td>one or more substances</td>
<td>two or more elements or compounds</td>
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Summary of Reaction Types

1. For each set of reactants listed below, identify the type of reaction that the reactants might undergo. List as many reaction types as may apply. Assume that all the reactants for the reaction are listed.
   
a. a compound and an element
b. two compounds
c. one compound
Summary of Reaction Types

1. For each set of reactants listed below, identify the type of reaction that the reactants might undergo. List as many reaction types as may apply. Assume that all the reactants for the reaction are listed.
   a. a compound and an element
      synthesis, combustion, SR
   b. two compounds
      synthesis, DR
   c. one compound
      decomposition
Summary of Reaction Types

2. For each set of reactant products listed below, identify the type of reaction that might have formed the products. List as many reaction types as may apply. Assume that all the productions for the reaction are listed.
   a. a compound and an element
   b. two compounds
   c. one compound
Summary of Reaction Types

2. For each set of reaction products listed below, identify the type of reaction that might have formed the products. List as many reaction types as may apply. Assume that all the productions for the reaction are listed.

a. a compound and an element
   decomposition, SR

b. two compounds
   decomposition, combustion, DR

c. one compound
   synthesis
3. Classify each of the following examples according to the type of reaction involved. List as many reaction types as may apply.

a. A match burns

b. The carbonic acid found in soft drinks breaks down into bubbles of carbon dioxide and water

c. Phosphorus and oxygen react rapidly, forming diphosphorus pentoxide

d. An iron nail is placed into a copper sulfate solution. Copper metal appears on the nail.
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   decomposition

c. Phosphorus and oxygen react rapidly, forming diphosphorus pentoxide.
   synthesis

d. An iron nail is placed into a copper sulfate solution. Copper metal appears on the nail.
   SR
Summary of Reaction Types

3. Classify each of the following examples according to the type of reaction involved. List as many reaction types as may apply.

   e. The acid in baking powder reacts with baking soda (NaHCO₃), forming carbon dioxide gas and other products.

   f. Water and sulfur trioxide react to form sulfuric acid.

   g. Copper wire is placed in a silver nitrate solution. The solution turns blue, which is the color of the copper ion, and solid silver forms on the wire.
Summary of Reaction Types

3. Classify each of the following examples according to the type of reaction involved. List as many reaction types as may apply.

e. The acid in baking powder reacts with baking soda (NaHCO₃), forming carbon dioxide gas and other products.
   DR - followed by decomposition, gas-forming, acid-base neutralization

f. Water and sulfur trioxide react to form sulfuric acid.
   synthesis

g. Copper wire is placed in a silver nitrate solution. The solution turns blue, which is the color of the copper ion, and solid silver forms on the wire.
   SR
Summary
Write, Balance and Predict Chemical Reactions:

- Write and balance chemical equations
- Identify evidence of chemical reactions
- Identify 6 types of chemical reactions
- Predict products of reactions
- Write total and net-ionic equations for single and double replacement reactions
Warm Up - Extra

Write complete balanced equations and name the type of reaction:

1. Aqueous solutions of aluminum chloride and potassium phosphate are mixed.
2. Methane (CH$_4$) is burned in air.
3. Sodium and chlorine gas are mixed.
4. A piece of chromium is put into a solution of nickel sulfate.
5. Copper (I) sulfide is heated.
6. Aqueous solutions of chloric acid (HClO$_3$) and potassium hydroxide are mixed.
7. A piece of lead is put into a solution of nitric acid (HNO$_3$).
Warmup (extra practice) not in notes

1. Write the complete balanced equation, total ionic equation and net ionic equation for the reaction between solutions of aluminum chlorate and potassium oxide.

2. Write the complete balanced equation, total ionic equation and net ionic equation for the acid-base neutralization reaction that occurs when aqueous nitric acid is mixed with aqueous potassium hydroxide.
Warmup
(not in notes)

1. Write the complete balanced equation, total ionic equation and net ionic equation for the reaction between solutions of aluminum chlorate and potassium oxide.

\[
\begin{align*}
2 \text{Al}(\text{ClO}_3)_3(\text{aq}) &+ 3 \text{K}_2\text{O}(\text{aq}) \Rightarrow \text{Al}_2\text{O}_3(\text{s}) + 6 \text{KClO}_3(\text{aq}) \\
2 \text{Al}^{3+}(\text{aq}) + 6 \text{ClO}_3^-(\text{aq}) + 6 \text{K}^+(\text{aq}) + 3 \text{O}^{2-}(\text{aq}) &\Rightarrow \text{Al}_2\text{O}_3(\text{s}) + 6 \text{K}^+(\text{aq}) + 6 \text{ClO}_3^-(\text{aq}) \\
2 \text{Al}^{3+}(\text{aq}) + 3 \text{O}^{2-}(\text{aq}) &\Rightarrow \text{Al}_2\text{O}_3(\text{s})
\end{align*}
\]
2. Write the complete balanced equation, total ionic equation and net ionic equation for the acid-base neutralization reaction that occurs when aqueous nitric acid is mixed with aqueous potassium hydroxide.

$$\text{HNO}_3(\text{aq}) + \text{KOH}(\text{aq}) \rightarrow \text{H}_2\text{O}(l) + \text{KNO}_3(\text{aq})$$

$$\text{H}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{K}^+(\text{aq}) + \text{OH}^-\text{(aq)} \rightarrow \text{H}_2\text{O}(l) + \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$$

$$\text{H}^+(\text{aq}) + \text{OH}^-\text{(aq)} \rightarrow \text{H}_2\text{O}(l)$$
When solutions of potassium hydroxide and aluminum chloride are mixed, they produce solid aluminum hydroxide and aqueous potassium chloride.

In your notes, write word, skeleton, balanced formula, total ionic and net ionic equations for this reaction.
Extra Warm up for early on

1. Name the following compounds:
   a) Na$_2$Cr$_2$O$_7$
   b) AlI$_3$
   c) SnO$_2$
   d) Fe(C$_2$H$_3$O$_2$)$_3$
   e) KHSO$_4$
   f) Co(NO$_2$)$_2$

2. Write the following as balanced chemical equations:
   a) iron (III) chloride + calcium hydroxide $\rightarrow$ iron (III) hydroxide + calcium chloride
   b) carbon + oxygen $\rightarrow$ carbon monoxide
   c) potassium nitrate $\rightarrow$ potassium nitrite + oxygen