

Chemical Reactions

Objectives

- ❑ State four observations that are evidence for a chemical reaction:
 - Release of a gas.
 - Production of an insoluble substance.
 - Permanent color change.
 - Heat released or absorbed.
 - ❑ Identify seven elements that occur naturally as diatomic molecules: H_2 , N_2 , O_2 , F_2 , Cl_2 , Br_2 , I_2 .
 - ❑ Write a chemical equation from the description of the equation.
 - ❑ Balance a chemical equation.
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Objectives

- ❑ List 5 types of chemical reactions:
 - Combination reaction.
 - Decomposition reaction.
 - Single-replacement reaction.
 - Double-replacement reaction.
 - Neutralization reaction.
 - ❑ Write a balanced chemical equation for a reaction between a metal and a nonmetal.
 - ❑ Write a balanced chemical equation for the
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Objectives

- ☐ Write a balanced chemical equation for the decomposition of a metal carbonate.
 - ☐ Write a balanced chemical equation for the decomposition that releases oxygen gas.
 - ☐ Use the activity series to predict whether a single replacement reaction will occur.
 - ☐ Write a balanced chemical equation for the reaction of a metal in an aqueous solution.
 - ☐ Write a balanced chemical equation for the reaction of a metal in an acid.
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- ☐ Write a balanced chemical equation for the reaction of an active metal in water.
 - ☐ Use the general solubility rules to predict whether an ionic compound dissolves in water.
 - ☐ Predict the products that result from a double replacement reaction.
 - ☐ Write a balanced chemical equation for the reaction between two aqueous solutions.
 - ☐ Write a balanced chemical equation for the reaction between an acid and a base.
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Evidence for Chemical Reactions

- ❑ Release of a gas.
 - ❑ Production of an insoluble substance (**precipitate**).
 - ❑ A permanent color change.
 - ❑ Heat being given off or absorbed
 - **Exothermic** – A reaction in which heat is given off.
 - **Endothermic** – A reaction in which heat is absorbed.
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Chemical Equations

- An equation for a general chemical reaction:



- A and B are **reactants**.
 - C and D are **products**.
 - $\rightarrow$ is the **yields** sign. It points from the reactants to the products.
 - + indicates that two or more reactants are involved, or that two or more products are produced.
 - Δ indicates that heat is given off or absorbed.
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Diatomic Molecules

☐ Diatomic Molecules:

- H_2
 - N_2
 - O_2
 - F_2
 - Cl_2
 - Br_2
 - I_2
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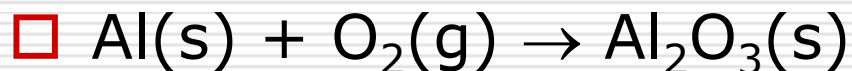
Balancing Equations

- The number of atoms of each element must be the same on each side of the yields sign.
 - Write the reactants and products.
 - Add coefficients to balance the equation.
 - Example:
 - Write the reactants and products:
 - $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow \text{HCl}(\text{g})$
 - Add coefficients to balance the equation:
 - $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$
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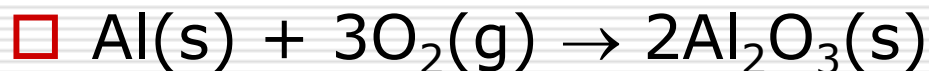
Balancing Equations

□ Example:

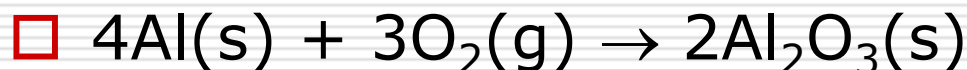
- Write the reactants and products:



- Add coefficients to balance the oxygen:



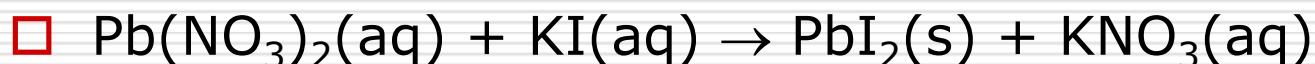
- Add coefficients to balance the aluminum:



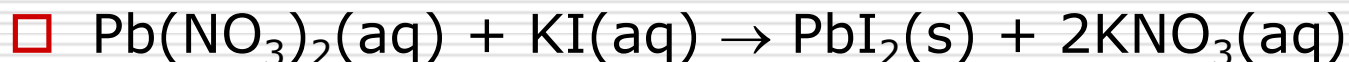
Balancing Equations

□ Example:

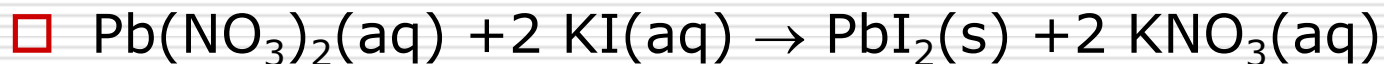
- Write the reactants and products:



- Add coefficients to balance the nitrate:



- Add coefficients to balance the potassium:



Balancing Equations

- ❑ A method for balancing equations:
 - Check to make sure that the formula subscripts are correct.
 - Balance each element in the equation by placing a coefficient in front of each substance. Coefficients of 1 are assumed and do not appear in the balanced chemical equation.
 - ❑ Begin balancing the equation with the most complex formula.
 - ❑ Balance polyatomic ions as a single unit unless the ion decomposes.
 - ❑ Use only whole number coefficients.
 - Check each element or polyatomic ion to verify that the same number of atoms appear on both sides of the equation.
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Balancing Equations

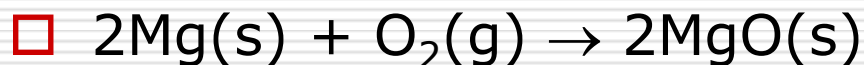
□ Examples:

- $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2(\text{aq}) + \text{K}_3\text{PO}_4(\text{aq}) \rightarrow \text{Ca}_3(\text{PO}_4)_2(\text{s}) + \text{KC}_2\text{H}_3\text{O}_2(\text{aq})$
 - $3\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2(\text{aq}) + 2\text{K}_3\text{PO}_4(\text{aq}) \rightarrow \text{Ca}_3(\text{PO}_4)_2(\text{s}) + 6\text{KC}_2\text{H}_3\text{O}_2(\text{aq})$
 - $\text{Al}_2(\text{SO}_4)_3(\text{aq}) + \text{Ba}(\text{NO}_3)_2(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + \text{Al}(\text{NO}_3)_3(\text{aq})$
 - $\text{Al}_2(\text{SO}_4)_3(\text{aq}) + 3\text{Ba}(\text{NO}_3)_2(\text{aq}) \rightarrow 3\text{BaSO}_4(\text{s}) + 2\text{Al}(\text{NO}_3)_3(\text{aq})$
 - $\text{H}_2\text{SO}_4(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + \text{HOH}(\text{l})$
 - $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{HOH}(\text{l})$
 - $\text{H}_2\text{CO}_3(\text{aq}) + \text{NH}_4\text{OH} \rightarrow (\text{NH}_4)_2\text{CO}_3(\text{aq}) + \text{HOH}(\text{l})$
 - $\text{H}_2\text{CO}_3(\text{aq}) + 2\text{NH}_4\text{OH} \rightarrow (\text{NH}_4)_2\text{CO}_3(\text{aq}) + 2\text{HOH}(\text{l})$
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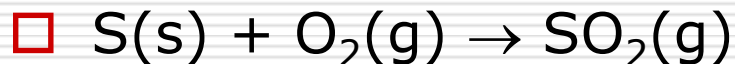
Classifying Chemical Reactions

☐ Combination Reactions: $A + Z \rightarrow AZ$

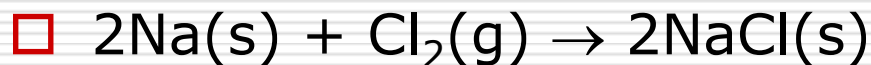
- Metal and oxygen gas:



- Nonmetal and oxygen gas:



- Metal and nonmetal:



Classifying Chemical Reactions

☐ Decomposition Reactions:

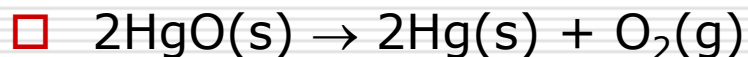
■ Decomposition of a Hydrogen Carbonate:



■ Decomposition of a Carbonate:



■ Decomposition of an oxide:



Classifying Chemical Reactions

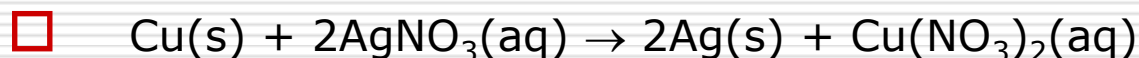
☐ Single Replacement Reactions: $A + BZ \rightarrow AZ + B$

■ The activity series for metals: $\text{Li} > \text{K} > \text{Ba} > \text{Sr} > \text{Ca} > \text{Na} > \text{Mg} > \text{Al} > \text{Mn} > \text{Zn} > \text{Fe} > \text{Cd} > \text{Co} > \text{Ni} > \text{Sn} > \text{Pb} > (\text{H}) > \text{Cu} > \text{Ag} > \text{Hg} > \text{Au}$

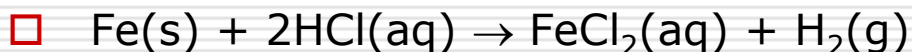
■ Active metals series: $\text{Li} > \text{K} > \text{Ba} > \text{Sr} > \text{Ca} > \text{Na}$

■ Activity series for the halogens: $\text{F} > \text{Cl} > \text{Br} > \text{I}$

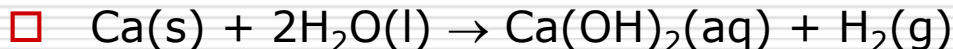
■ Metal and aqueous solution:



■ Metal and aqueous acid solution:

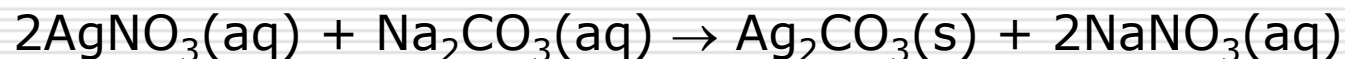
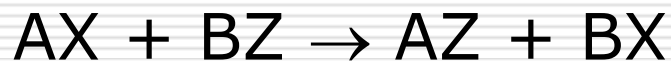


■ Active metal and water:



Classifying Chemical Reactions

- Double Replacement Reactions:



Solubility Rules

1. Alkali metals ions and the ammonium ion are generally soluble.
 2. The acetate ion is generally soluble.
 3. The nitrate ion is generally soluble.
 4. Halide ions except silver, mercury, and lead are generally soluble.
 5. The carbonate ion is generally insoluble except for rule 1.
 6. The chromate ion is generally insoluble except for rule 1.
 7. The phosphate ion is generally insoluble except for rule 1.
 8. The sulfide ion is generally insoluble except for rule 1 and cadmium, barium, and strontium.
 9. The hydroxide ion is generally insoluble except for rule 1 and calcium, strontium, and barium.
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Classifying Chemical Reactions

☐ Neutralization Reactions:

