

# Chemical Reactions

(Chapter 17)

**Student Learning Objective:** Balance chemical equations; convert between moles, grams and molecules; list factors that affect reaction rates; explain activation energy; and calculate the net energy change for chemical reactions.

1. *What is a chemical reaction?*
2. *How is a chemical equation balanced?*
3. *How are moles, particles, and grams related?*
4. *What can cause reaction rates to vary?*
5. *What is activation energy?*
6. *How is the change in energy calculated for a chemical reaction?*

*What is a chemical reaction?*

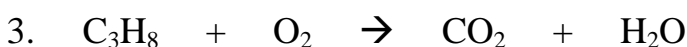
❖ **A chemical reaction is the process of forming new substances.**

- Atoms are combined to form molecules.
- Molecules separate into atoms.

*How is a chemical equation balanced?*

- ❖ A chemical equation is balanced when there are the same numbers of each type of atom on each side of the equation.
  - Subscript numbers indicate a chemical bond and cannot be changed.
  - Coefficients indicate the quantity of each compound and can be changed.

**Question:** What are the coefficients that balance the following equations?



*How are moles, particles, and grams related?*

- ❖ There are always **6.022 x 10<sup>23</sup>** atoms or molecules in 1 mole of a substance.
- ❖ The coefficients in a chemical equation indicate the number of moles.
- ❖ The atomic mass shown on the periodic table is also the number of grams in 1 mole of atoms.

<b>Atomic mass = <math>\frac{\text{grams}}{\text{mole}}</math></b>
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**Questions:**

1. How many grams are in one mole?
  - a. Hydrogen
  - b. Gold
  - c. Water
2. How many atoms or molecules are in one mole?
  - a. Hydrogen
  - b. Gold
  - c. Water
3. How many moles are there in 36 grams of water?
4. How many molecules of water are in 36 grams of water?
5. If 5 grams of CO<sub>2</sub> is added to a can of soda, how many molecules of CO<sub>2</sub> are in the can?
6. How many grams of each reactant are needed and how many grams of product are produced in the reaction:  $\text{Al} + \text{Br}_2 \rightarrow \text{Al}_2\text{Br}_3$ ? If the concentration of the bromine solution is 244 g/L, how many liters of bromine solution must be combined with the aluminum?

What can cause reaction rates to vary?

❖ There are many factors that can affect the rate of a reaction.

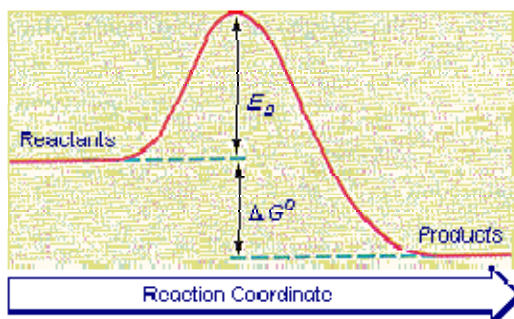
- 1) Concentration
- 2) Temperature
- 3) Surface area
- 4) Sunlight
- 5) Catalysts

### Questions:

1. Why do you think there are warnings on some medications not to break, crush, or chew the pill?
2. Why are photographic prints processed in the dark?

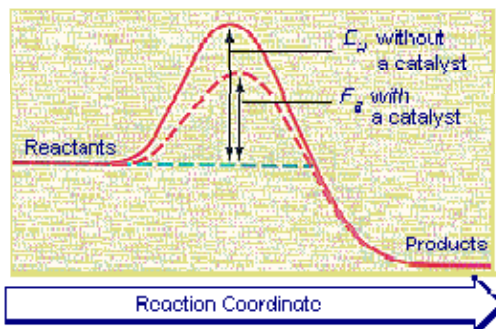
What is activation energy?

❖ **The activation energy is the energy molecules must absorb from their environment to break existing bonds and react.**



<http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch22/activate.html>

❖ **The role of the catalyst is to reduce the activation energy, so the reaction rate is accelerated.**



- ❖ A catalyst is a substance that is added to the reaction to speed up the reaction; it does not become part of a product molecule.
  - Catalysts provide a different pathway.
  - Catalysts lower the activation energy of one of the reactants.
  - Catalysts always reappear as a product.

**Question:** Can you think of something that uses a catalyst?

*How is the change in energy calculated for a chemical reaction?*

- ❖ Chemical reactions may cause a change in temperature.
- ❖ If there is a temperature change, then the potential energy of the reacting substances is different from the potential energy of the products.

<b>Exothermic Reaction</b>	<b>Endothermic Reaction</b>
<b>Energy is <i>released</i></b>	<b>Energy is <i>absorbed</i></b>
<b>Reactants have <u>higher</u> PE</b>	<b>Reactants have <u>lower</u> PE</b>

- ❖ The law of conservation of energy still holds during exothermic and endothermic reactions.
- ❖ For a particular bond to form or break requires particular **bond energy**.
- ❖ **The amount of energy absorbed to break a bond is *equal* to the amount of energy released when the bond forms.**
- ❖ The net bond energy for the entire reaction indicates whether the process was exothermic or endothermic.

**Examples:**

1. Combination of nitrogen and hydrogen:  $\text{N}_2 + \text{H}_2 \rightarrow \text{N}_2\text{H}_4$
2. Combustion of ethylene:  $\text{H}_4\text{C}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
3. Splitting water:  $\text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}$

