Chapter Fourteen: Changes in Matter

- 14.1 Chemical Reactions
- 14.2 Types of Reactions
- 14.3 Energy and Chemical Reactions
- 14.4 Nuclear Reactions

Chapter 14.3 Learning Goals

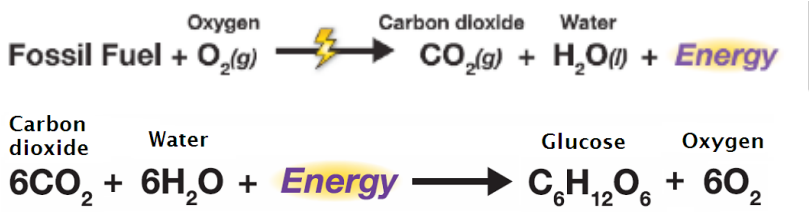
- Contrast endothermic and exothermic reactions.
- Explain why activation energy is needed to begin chemical reactions.
- Describe factors that may influence the rate at which a chemical reaction occurs.

14.3 Energy and Reactions

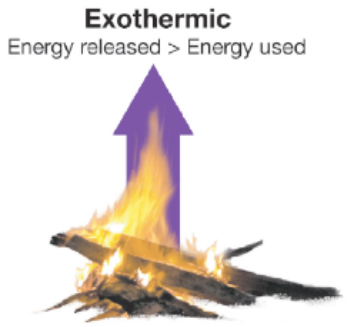
- **Energy is involved in chemical reactions in two ways:**
  1. **to break some (or all) bonds between atoms in the reactants so the atoms can form new bonds or**
  2. **when the atoms or products form new bonds to make new products.**

14.3 Two Types of Reactions

- We classify chemical reactions based on how the energy of the reactants compares to the energy of the products.



14.3 Exothermic reactions



- If forming new bonds releases more energy than it takes to break the old bonds, the reaction is exothermic.

14.3 Exothermic reactions

- A good example is the reaction of hydrogen with oxygen.

Once started, exothermic reactions tend to keep going as each reaction releases more energy to fuel neighboring molecules.

14.3 Endothermic reactions

- If forming new bonds in the products releases less energy than it took to break the original bonds, the reaction is endothermic.

Endothermic
Energy used > Energy released

14.3 Endothermic reactions

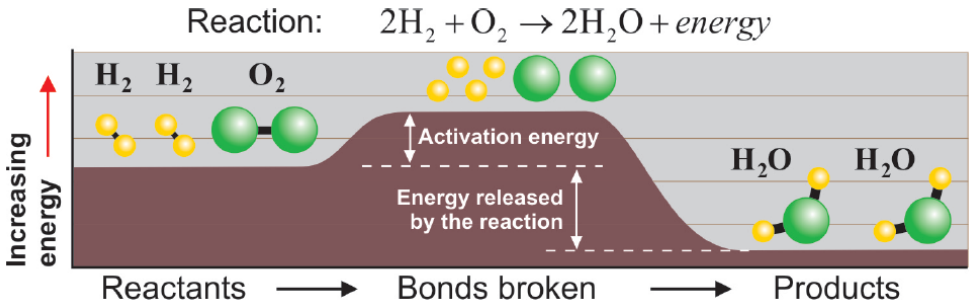
- An important endothermic reaction is photosynthesis.
- Plants need energy from sunlight to make glucose and oxygen from carbon dioxide and water.

Carbon dioxide + Water + Energy → Glucose + Oxygen

$$6CO_2 + 6H_2O + Energy \longrightarrow C_6H_{12}O_6 + 6O_2$$

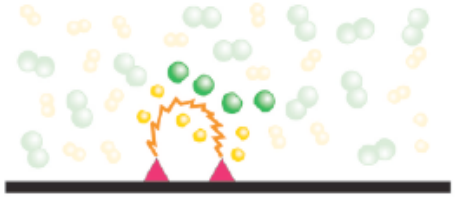
14.3 Activation Energy

- **Activation energy is the energy needed to begin a reaction and break chemical bonds in the reactants.**

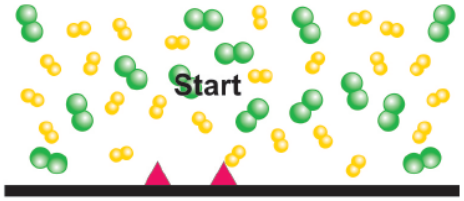


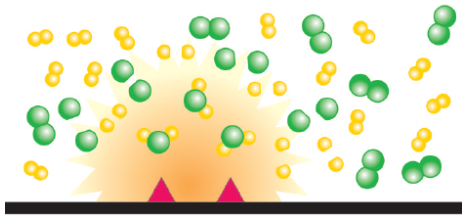
14.3 Activation Energy

- This is why a flammable material like gasoline does not burn without a spark or flame.



Energy from a spark splits a few nearby molecules.



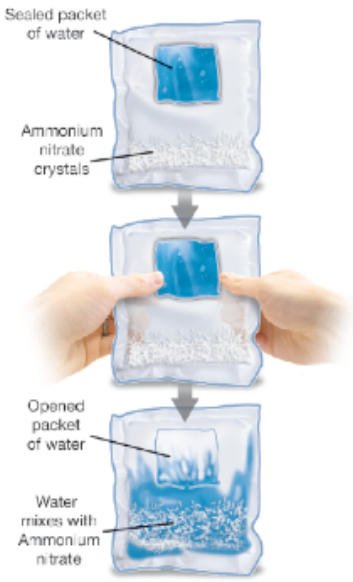


14.3 Examples of Endothermic Reactions

- Most of the reactions used in industry to produce useful materials require more energy than they produce.
- One process that uses endothermic reactions is the refining of ores to produce useful metals.

14.3 Examples of Endothermic Reactions

- Most of the reactions used in industry to produce useful materials require more energy than they produce.
- The reaction taking place inside an instant cold pack is endothermic.



14.3 Examples of Endothermic Reactions

- When you squeeze the plastic bag the water reacts with the ammonium nitrate crystals, and the reaction dissolves the ionic bonds in the ammonium nitrate.

$$NH_4NO_{3(s)} + H_2O_{(l)} + Energy \longrightarrow NH_4^{+}{}_{(aq)} + NO_3^{-}{}_{(aq)}$$

14.3 Examples of Endothermic Reactions

$$NH_4NO_{3(s)} + H_2O_{(l)} + Energy \longrightarrow NH_4^{+}{}_{(aq)} + NO_3^{-}{}_{(aq)}$$

- The reaction is also a dissolution reaction.
- Dissolution occurs when an ionic compound (like ammonium nitrate) dissolves in water to make an ionic solution.

14.3 Reaction Rates

- In all phases of matter, atoms and molecules exhibit random motion.
- This concept is part of the kinetic theory of matter.
- The speed at which atoms or molecules move depends on the state of matter and temperature.

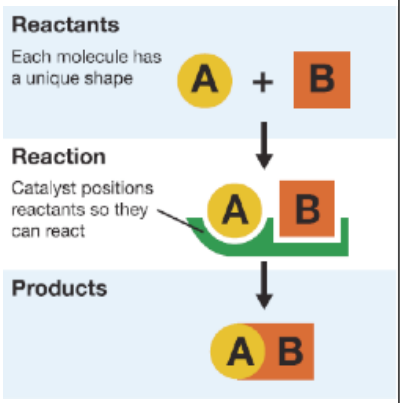
14.3 Reaction Rates

- The reaction rate for a chemical reaction is the change in concentration of reactants or products over time.

- Reaction rates can be increased by:
  1. adding heat to increase molecular motion
  2. increasing the concentration of the reactants
  3. increasing the chances that two molecules will collide.

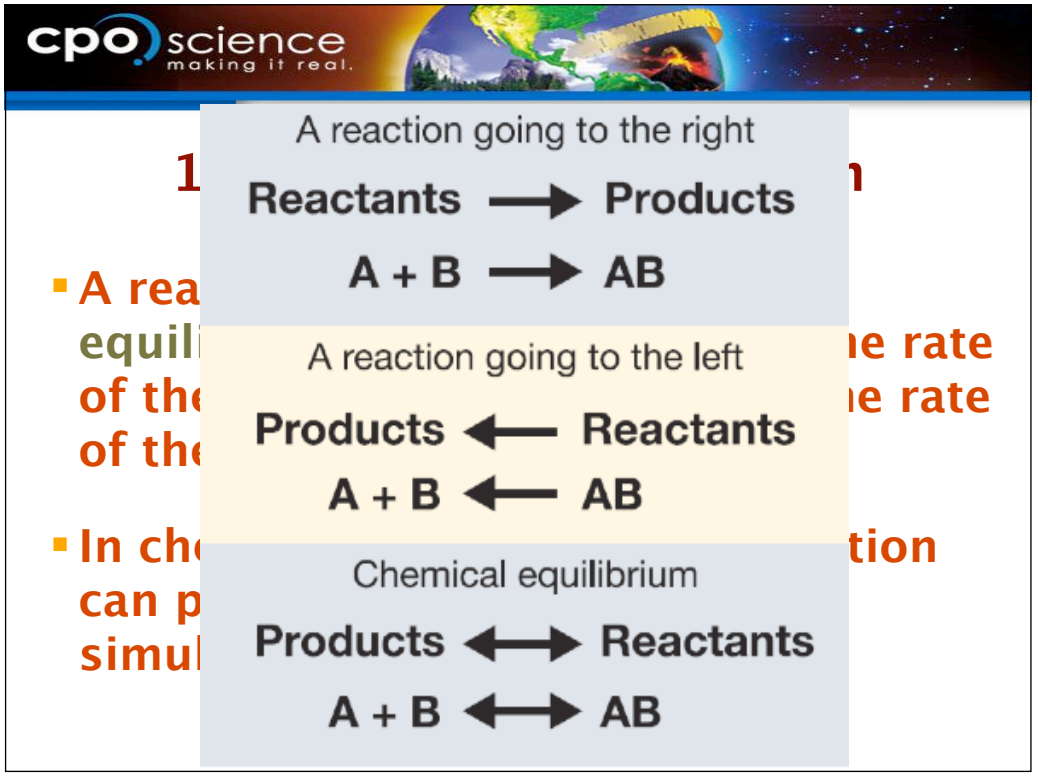
14.3 Catalysts

- A catalyst is a molecule that can be added to a reaction to speed it up.
- Catalysts work by increasing the chances that two molecules will be positioned in the right way for a reaction to occur.



14.3 Inhibitors

- Reactions can also be slowed down by molecules called inhibitors.
- Inhibitors bind with reactant molecules and effectively block them from combining to form products.


cpo science
making it real.
A reaction going to the right
Reactants → Products
A + B → AB
A reaction going to the left
Products ← Reactants
A + B ← AB
Chemical equilibrium
Products ⟷ Reactants
A + B ⟷ AB