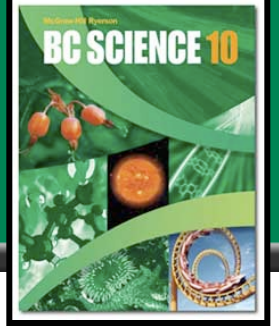
6.2 Factors Affecting the Rate of Chemical Reactions



- **Often, controlling the rate of a chemical reaction is as important as having the reaction occur in the first place.**
  - **Many factors can determine the rate at which a chemical reaction occurs.**
- **To make a reaction happen quickly:**
  - **Increase the temperature where the reaction occurs.**
  - **Increase the concentration of reactants.**
  - **Increase the amount of surface area that reacts.**
  - **Add a catalyst or remove an inhibitor.**
- **To make a reaction happen slowly:**
  - **Decrease the temperature where the reaction occurs.**
  - **Decrease the concentration of reactants.**
  - **Decrease the amount of surface area that reacts.**
  - **Remove a catalyst or add an inhibitor.**

A bicycle chain slowly rusts.

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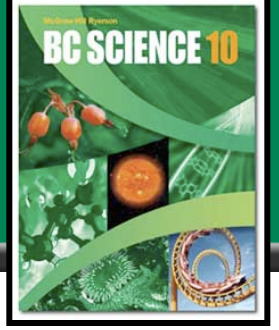
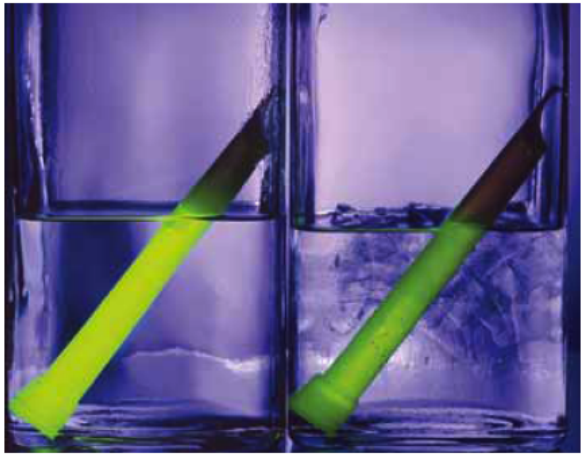
Temperature



- **Temperature is the average kinetic energy of molecules.**
  - The more energy molecules have, the higher the temperature.
  - When molecules have more energy, they move around more, bump into other molecules more, and therefore react faster.
- **The rate of reaction changes with the temperature.**
  - Higher temperature = faster reaction rate, and vice versa.
  - Sometimes we want slower reactions (we use a fridge to prevent spoilage).
  - Sometimes we want faster reactions (we cook food to speed up the production of new molecules).



The chemical reaction rate is higher in hot water than in cold water.

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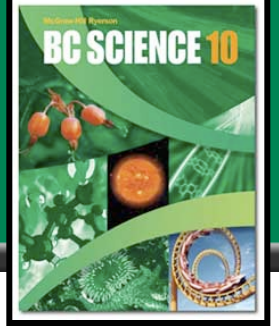
Concentration



- **Concentration refers to how many molecules of a substance exist in a certain volume.**
  - **Concentration is how much solute is dissolved in solution.**
  - **Concentration is measured in mass per unit volume (g/L).**
- **Usually, the higher the concentration of reactants, the faster the reaction occurs.**
  - **Since there are more molecules per unit volume in high concentrations, there are more opportunities for molecules to collide and react.**
  - **A splint of wood glows brighter in highly concentrated oxygen than in normal air with a lower concentration of oxygen.**

Changing the concentration of O_2 changes the intensity of flames.

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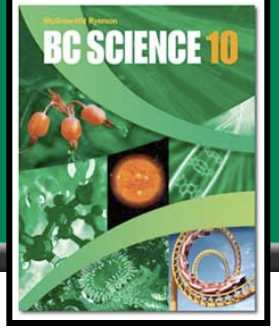
Surface Area



- **Chemical reactions occur when and where atoms and compounds collide.**
  - **The more atoms and molecules there are to collide, the higher the reaction rate.**
- **Increasing surface area increases the rate of reaction.**
  - **Surface area can be increased by creating smaller pieces.**
    - **A powdered substance has far more surface area than one large chunk.**
  - **The increase in surface area must also be exposed for reaction; a powder only reacts more quickly if it is spread into the air instead of lying on a pan.**

Steel wool (on the right) is made up of small strands of steel, and therefore has much more surface area than an equivalent amount of solid steel.

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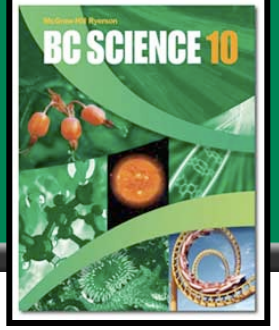
Catalysts



- Sometimes, increasing the temperature or concentration is not a desirable method to increase reaction rate.
  - Changing these two variables may be impractical or dangerous.
- A catalyst is a chemical that allows a reaction to occur more quickly without actually participating in the reaction itself.
  - The catalyst speeds up the reaction rate but does not get used up as a reactant.
  - Catalysts often lower the amount of energy necessary to break the bonds in the reactants.
- Enzymes are an example of biological catalysts.
  - Saliva has enzymes that help speed the breakdown of starches when they enter the mouth.

Salivary amylase increases the digestion of starches.

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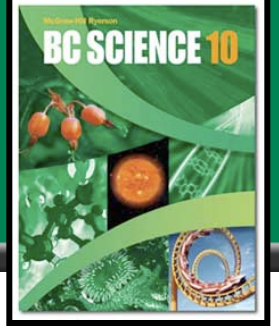
Catalysts (continued)



- **A catalytic converter is a device installed in cars to decrease pollution.**
  - Car exhaust passes through the catalytic converter before leaving the car.
  - Catalysts found in the honeycomb-shaped filters in the converter help to change many of the pollutants into less harmful substances.
    - Poisonous carbon monoxide is changed into CO_2.
    - Hydrocarbons are converted into CO_2 and H_2O.
    - Nitrogen oxides are changed into N_2 and O_2.
      - $2N_2O_3 \rightarrow 2N_2 + 3O_2$
  - Inhibitors are substances that slow down a reaction by getting in way of the molecules when they're trying to react

A catalytic converter.

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Take the Section 6.2 Quiz