

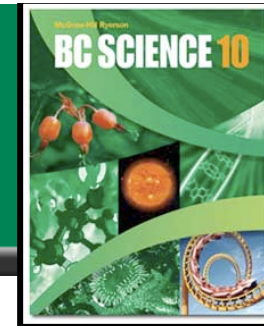
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- for students to copy in their own hand-writing
 - ◆ in order to complete their class notes
 - ◆ if student did not have enough time in class
 - ◆ if student was away and missed this section
- for assistants and tutors to follow progress of the concepts taught

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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 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 (if present), or add an inhibitor

A bicycle chain slowly rusts

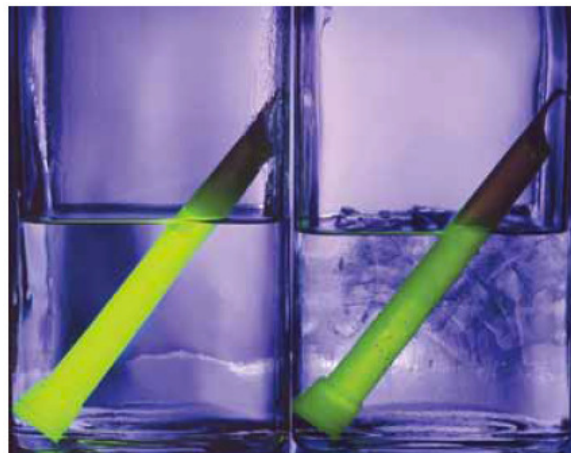


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Temperature

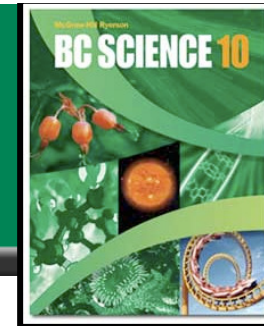


- **Temperature is a measure of the average energy of molecules.**
 - ◆ The more energy molecules have, the higher the temperature.
 - ◆ When molecules have more energy, they move around more, bump into other molecules more, and therefore react faster.
- **The rate of reaction changes with the temperature.**
 - ◆ 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).



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Concentration



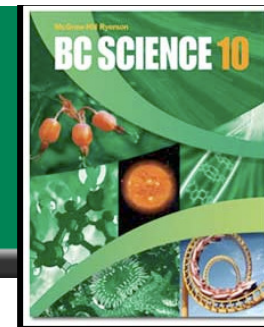
- **Concentration refers to how many molecules of a substance exist in a certain volume.**
 - ◆ How much solute (what's dissolved) is there in a certain amount of solvent (what the substance is dissolved in).
 - ◆ Concentration is measured in mass per unit volume (g/L).
- **Usually, the higher the concentration 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.**
 - ◆ **Since there are more atoms and compounds exposed to react, more reaction takes place.**
 - ◆ **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.



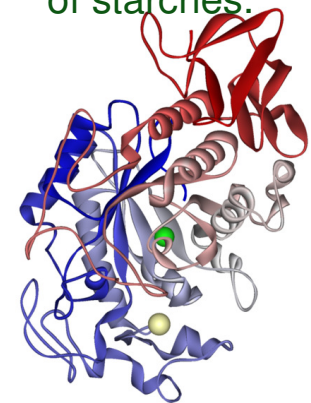
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Catalysts



- 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.

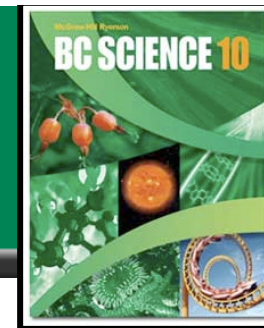
Salivary amylase
increases the digestion
of starches.



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Catalysts (continued)



- A catalytic converter is a device installed in all 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.
 - 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
 - $2\text{N}_2\text{O}_3 \rightarrow 2\text{N}_2 + 3\text{O}_2$



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