

# Introducing Chemical Concepts with Food

*Susan J. Pater*

## Overview

This unit is written for high school students enrolled in a first year general chemistry course. It includes hands-on activities for students as well as teacher demonstrations. The unit is divided into nine topics: properties of matter, classification of matter, electrolytes and electrochemistry, chemical reactions, acids and bases, rate of reaction, oxidation and reduction, states of matter, and solutions. Each topic contains a teacher demonstration and discussion section and a student activity section. One or more of the materials needed to perform each activity or demonstration will be a food-related product.

## Rationale

The old familiar saying, "You can lead a horse to water but you can't make him drink," is an everyday occurrence in an educators life. As educators we must constantly create and develop new ways to ensure our students drink from the fountain of knowledge. We are not only providers of that knowledge but we must enable students to observe how that knowledge is relevant to their lives if they are going to retain it over a period of time. Perhaps by adding some sugar to the water we will be able to become more successful with this process.

Teaching a first year general chemistry course can be very challenging. The main challenge is to help students "think chemistry." Chemistry deals with all the materials of the universe, including all living things. Everything is composed of atoms chemically combined to form molecules.

Chemistry is a difficult subject for most students. It may seem very strange at first. Perhaps, learning chemistry is much like learning a foreign language. Students are asked to think and solve problems in an entirely different way than they have done in other classes. They must become receptive to a new way of thinking, which allows them to be caught up in the excitement of the subject.

Most high school chemistry textbooks are content oriented where students are presented with chemical facts, formulas, and principles. Only a few textbooks make a conscious effort to help students develop critical-thinking and problem-solving skills that will aid them later in life. Students must be encouraged to develop a full understanding of chemical concepts. They must also be guided to develop their own mental models of basic concepts. Students often leave a chemistry course being confused and are reluctant to enroll in another chemistry course or worse yet another science course. This limits their career choices and their ability to discuss societal issues involving science.

## Objectives

The main objective of this unit is to encourage high school students to explore basic chemical concepts and to have them relate what is observed or discussed in the classroom to the world outside the classroom. Students will be able to demonstrate an understanding of basic chemical concepts by relating the concept to a food product.

This unit will incorporate many of the Science and Technology standards adopted by the Pittsburgh Public Schools. (see appendix)

It will also incorporate some of the Communications, Mathematics, and Family and Consumer Sciences standards adopted by the Pittsburgh Public Schools. (see appendix)

### **Strategies**

Through the use of various food items, the natural curiosity of students can be used as a motivational tool to aid in the comprehension of chemical concepts. Most high school students are constantly eating and thinking about food. This then becomes an ideal link between the student and the subject of chemistry.

This unique approach will make chemistry a more enjoyable but still concept based class for students. Instead of boring students with lecturing to teach new chemical concepts, I hope to successfully introduce topics with teacher demonstrations and discussions. I also want students to have the opportunity to perform more hands-on activities. This will be especially important when block scheduling becomes a reality in most city high schools in the near future.

### **Classroom Activities**

#### Properties of Matter

Density is one of the most important properties of matter. It is defined as the mass of a substance per unit volume. Many students have the misconception that density and mass are synonymous with one another.

#### *Teacher Demonstration and Discussion*

One teacher demonstration of density involves the use of different types of potatoes. According to McGee, there are two distinct types of potatoes: the moist, "waxy" type, which is used for potato salad and the dry, "mealy" type, which are better for baking (1). When placed in a 10% saltwater solution, the baking potato sinks to the bottom while the other type floats. Students should then be asked to hypothesize why this happens. Point out to students that most baking potatoes usually contain more starch than the "waxy" type.

*Materials needed:* one "mealy" potato, one "waxy" potato, and a 10% saltwater solution

#### *Student Activity*

Another interesting student activity involving density is a series of measurements used to calculate the density of a Twinkie. This can be done in two ways. First obtain the mass of Twinkie by using a balance. Then calculate the volume by using a ruler to measure the outside dimensions (length x width x height). A second way to calculate the volume is by use of a blender and a graduated cylinder. Puree the Twinkie in a blender for a short period of time and then tightly pack the resulting mixture in a 50 mL graduated cylinder and measure the volume. Have students compare the two densities and calculate the percent of air by volume. Twinkies are approximately 68% air by volume (2).

*Materials needed:* one Twinkie, a triple beam balance, a metric ruler, a 50 ml graduated cylinder, and a blender

### Classification of Matter

Matter is defined as anything that has mass and occupies volume. All matter is classified into two main categories: substances and mixtures. Substances include all elements and compounds. Mixtures can further be separated into homogeneous mixtures, which are commonly called solutions, or heterogeneous mixtures. Heterogeneous mixtures are usually easier to separate than homogeneous mixtures. The components of a mixture must be separated in different ways because of the differences in the sizes and interactions between molecules.

### *Teacher Demonstration and Discussion*

A teacher demonstration to introduce the various physical methods used to separate a mixture involves the use of Italian salad dressing. Have students suggest a method for separating the salad dressing into its original ingredients. This may be done as a group or individual activity. At the completion of the activity, ask a few groups of students to share their method with the entire class. Demonstrate commonly used techniques such as filtration, decanting, distillation, and evaporation using the salad dressing.

*Materials needed:* one bottle of Italian salad dressing, a funnel, a piece of filter paper, one hot plate, an evaporating dish, a beaker, and a stirring rod

### *Student Activity*

Another activity involving the separation of a mixture involves breakfast cereals. Many breakfast cereals contain iron in its elemental state and not in a soluble ionic form. It is surprisingly easy to remove the iron from the cereal. Have students fill a 600 –1000 mL beaker about one-third full with crushed iron fortified cereal (Total, Special K, etc.). Add enough water to completely cover the cereal and let stand until the cereal becomes soggy. Place a magnetic stir bar into the beaker and place the beaker on a magnetic stirrer. Stir on low for several minutes. Remove the magnetic stir bar and observe. Students will be able to observe iron metal attached to the bar. The iron is a food grade iron powder, which will react with stomach acid to produce iron ions, which are easily absorbed into the digestive tract. Remind students that iron is an essential nutrient for the formation of hemoglobin in blood.

*Materials needed:* one box of iron fortified cereal, a magnetic stirrer, a magnet, a beaker, and water.

### *Student Activity*

Use of a process called chromatography can separate a solution. The dyes used to make food coloring can easily be separated by the use of chromatography paper and a solvent such as water or ethanol. Scrape the colored coating off a lollipop and crush it using a mortar and pestle. Add a small amount of water to make a colored liquid. Drop some of the colored liquid onto a strip of chromatography paper about two centimeters from the bottom. Place a small amount of ethanol in a beaker and stand the strip in the beaker so that the bottom edge touches the solvent. The colors will separate on the paper according to the different food colorings used in the lollipop. Be sure to have students try a variety of lollipop colors for comparison.

Using other candies such as Smarties or M&M's could modify this activity. To remove coloring from these candies, have students lick the edge and rub the moistened candy on the chromatography paper. Repeat this process several times to obtain a dense colored line on the paper.

*Materials needed:* a variety of lollipops, a mortar and pestle, a knife, water, a dropper, a small beaker, ethanol, and chromatography paper

### Electrolytes and Electrochemistry

Compounds that conduct an electric current in aqueous solution or in the molten state are known as electrolytes. This is due to the fact that ions are free to move about in the solutions. The degree of conductivity depends on the solubility of the ionic compound and the number of ions present in the solution. Covalent compounds do not contain ions and are thus referred to as nonelectrolytes.

### *Teacher Demonstration and Discussion*

To introduce this topic, a simple teacher demonstration involves salt and sugar. Using a conductivity tester, test the following: salt crystals, a dilute solution of salt water, a more concentrated salt water solution, sugar crystals, a dilute solution of sugar water, and a more concentrated solution of sugar water. Before each test have students predict whether the substance will be a good electrolyte, a poor electrolyte, or a nonelectrolyte and give a reason why. The more concentrated the salt-water solution the better the conductivity. All sugar solutions will be nonelectrolytes.

*Materials needed:* a conductivity tester, six small beakers, sodium chloride, sucrose, and water

### *Student Activity*

Electrochemistry uses a chemical reaction to generate electricity. An ordinary battery is an example of electrochemistry in everyday life. One interesting activity for students involves

making a battery from a lemon. The lemon should first be rolled gently on a hard surface, such as a tabletop, to make it really juicy inside. Caution students not to roll too hard and rupture the lemon peel. Two different metal strips are needed to act as the electrodes. Copper wire and a strip of zinc are good to use or a steel paper clip in place of the zinc strip. Push the pieces of metal into the lemon so they are as close together as you can get them without touching one another. Electrons will migrate to one electrode creating a negatively charged terminal and at the other electrode there will be a loss of electrons creating a positive terminal. Connect two lemons together in series using a very thin wire. A single lemon produces about .7 volts of electricity. Thus 2 lemons should produce enough electricity to power an inexpensive digital watch which uses about 1.5 volts. Finally, have students connect more lemons together and try to light a small light bulb from a flashlight.

*Materials needed:* a lemon, two different metal strips (copper wire, zinc strip or steel paper clip), pieces of fine wire, an inexpensive digital watch, and a small light bulb from a flashlight

## Chemical Reactions

A chemical reaction is a process in which the original substances (reactants) undergo change to form new substances (products). The new substances formed have a different set of physical and chemical properties. During a chemical reaction, bonds between atoms are broken, atoms are rearranged, and new bonds are formed. The driving force for chemical reactions is stability. Thus, most chemical reactions are exothermic, which means that heat is released. The products have less energy than the reactants. Chemical reactions are classified into five general types: combination (synthesis), decomposition, single displacement, double displacement, and combustion.

### *Teacher Demonstration and Discussion*

A double displacement reaction can be demonstrated by simply mixing vinegar (acetic acid) and baking soda (sodium bicarbonate) together. Have students predict the products and write a balanced chemical equation for the reaction.

*Materials needed:* vinegar (acetic acid) and baking soda (sodium bicarbonate)

### *Student Activity*

A somewhat "smelly" reaction for students to perform is the decomposition of table sugar (sucrose). Have students place a spoonful of sugar into a test tube. Using a test tube holder, heat the sugar for several minutes by holding it over the flame of a Bunsen burner. Have students observe and record any changes that occur as the sugar is heated. Be sure to do this in a well-ventilated room. At the completion of the activity, students should be able to predict the products of the reaction and write a balanced chemical equation. The products are water vapor and carbon.

Another alternative is to use baking soda instead of the sugar. It is not as dramatic and produces very little smell. Place some baking soda in an evaporating dish. Add 3.0 M HCl to the dish and observe. Have students conduct a carbon dioxide test by holding a burning wood splint above the

dish. If the flame goes out, carbon dioxide is present as one of the products. The other products are sodium chloride and water. Remind students this is a double displacement reaction.

*Materials needed:* sucrose, a test tube, a test tube holder, baking soda (sodium bicarbonate), evaporating dish, a Bunsen Burner and a wood splint

## Acids and Bases

Acids and bases have very different chemical properties. Acids taste sour, react with metals, and are proton donors while bases taste bitter, feel slippery and are proton acceptors. A solution with a pH less than 7 is said to be acidic. On the other hand, a solution with a pH greater than 7 is classified as basic. A neutral solution has a pH of 7. When an acid reacts with a base a neutralization reaction occurs producing water and a salt.

### *Teacher Demonstration and Discussion*

To introduce this topic to students, ask students to hypothesize about the chemical reactions involved with baking powder. Begin by having students identify common foods made with baking powder. Next, list the main ingredients of baking powder and the chemical formula for each on the board. Students should be able to recognize that sodium bicarbonate is a base and the other substance as an acid. (The acid varies with brand name and type. Some common acids used are potassium tartrate, monocalcium hydrogen phosphate and sodium aluminum sulfate.) Ask students to predict why the acid and base are not reacting when mixed in the powder. The neutralization reaction will not occur until the dry ingredients are mixed with the wet ingredients. This may be in the form of water, milk, or some similar liquid. The acid used determines the speed of the neutralization reaction. This is important because it affects how quickly the batter must be mixed and cooked. Double-acting baking powders have two different acids. The first one reacts with the sodium bicarbonate at room temperature while the second one reacts later after the batter has been baking awhile and the temperature has risen. This insures a prolonged production of carbon dioxide and a lighter and tastier baked product.

*Materials needed:* baking powder and double-acting baking powder

### *Student Activity*

Students can prepare their own acid/base indicator solution and test various food items to determine which are acidic, basic or neutral based on color change. One simple indicator solution involves red cabbage. Cut a few red cabbage leaves into smaller pieces and place in a beaker. Add enough water to cover the cabbage leaves. Boil the mixture until the color of the water is purple. After straining the liquid, discard the discolored leaves. The purple liquid is the red cabbage indicator. The indicator turns from purple to red in the presence of an acid and from purple to blue in the presence of a base. Students can test a variety of foods such as soft drinks, various kinds of fruit juices, tap water, salad dressings, vegetables, and etc.

Another variation of the previous activity would be to use the spice turmeric as an indicator. Turmeric is a member of the ginger family and is a bright yellow colored underground stem that

looks like a thickened root. It is used as a dye in some dairy products such as margarine and butter. To make a turmeric indicator solution, simply add a small amount of turmeric to some alcohol. The solution will immediately turn yellow and is ready to use. When added to a basic substance the solution turns brownish-red and when mixed with an acidic substance the color changes to yellow. Use the turmeric indicator solution to test the same items listed in the above activity. At the completion of the lab activity, have students suggest other food related that might be used as indicators. Things such as rhubarb, beets, red plums, and black tea are possible alternatives that might be used by students as an extension outside the classroom.

*Materials needed:* red cabbage, a large beaker, one hot plate, a large filter or strainer, a variety of food items, turmeric and alcohol

## Rates of Reaction

The rate of a reaction describes how fast reactants are transformed in products. In order for a chemical reaction to occur, the reacting molecules must collide at the correct orientation and with sufficient energy. Several factors can affect the rate of a reaction. These include temperature, concentration, particle size and presence of a catalyst. A catalyst speeds up a chemical reaction by lowering the activation energy but is not permanently consumed by the reaction. It is therefore reusable in future chemical reactions. Industrial chemists usually want to increase the rate of a reaction in order to maximize profit, however food chemists encounter the opposite problem. They must find ways to slow the rate of food spoilage in order to increase the shelf life of a food item. Inhibitors slow the rate of a chemical reaction by either interfering with a catalyst or causing the reaction to take other routes that produce side products.

### *Teacher Demonstration and Discussion*

Lead a discussion with students in the factors used by food chemists to decrease the rate of food spoilage. Many food products are refrigerated which lowers the temperature of the molecules and thus decreases the number of collisions between molecules so the reaction rate is lowered. Other food products contain food preservatives (inhibitors) such as sodium benzoate, calcium propionate, and potassium sorbate. Calcium propionate is often used in bread products because it is effective in preventing the growth of mold (3). Sodium benzoate is also found in a variety of foods. Have students research other methods of food preservation such as canning, drying, and salting. Another activity would be to have students make a table listing food products at home and the food preservatives found in each. Have students share their findings with fellow classmates.

*Materials needed:* sample food labels

### *Student Activity*

Another student activity involving two factors that increase the rate of a reaction uses dried eggshells. Prior to class, the teacher should remove the membrane from eggshells and allow the shells to dry. Students will obtain about one fourth of an eggshell and grind it into very small pieces using a mortar and pestle. Students should be able to state the reason why small pieces

react faster than one large piece. Measure the mass of a piece of filter paper and record. Add approximately 0.20 g of eggshell to the filter paper and record the combined mass. Place the eggshell into a small beaker and add 5.0 mL of 3.0 M HCl. Stir the eggshell and the acid periodically. Students should be able to state why stirring is necessary. When the reaction stops, filter the remaining solution using the original piece of filter paper. Allow the filtrate to dry overnight and measure the mass. The percentage of calcium carbonate in the eggshell can be determined by dividing the mass of the eggshell after the reaction with the mass of the eggshell before reacting and multiplying by one hundred.

A nice variation to this activity would be to time the rate of reaction using larger pieces of eggshell and compare with the time of the smaller pieces. Be sure to use the same mass of eggshell. A second alternative would be to use another type of eggshell (perhaps compare brown eggs with white eggs). Is the percentage of calcium carbonate the same?

*Materials needed:* dried eggshells, a mortar and pestle, one triple beam balance, a piece of filter paper, a small beaker, a 10 ml graduated cylinder, 3.0 M HCl, and a stirring rod

## Oxidation and Reduction

In oxidation and reduction reactions, one substance is oxidized (loses electrons) while another substance is reduced (gains electrons). During this transfer process, the number of electrons lost is equal to the number of electrons gained. Overall charge is conserved. Hence, these two processes must occur simultaneously. Many chemical reactions are redox reactions.

### *Teacher Demonstration and Discussion*

One way to begin a unit on oxidation and reduction is to use common fruits and vegetables. Cut some various fruits and vegetables and have students observe the discoloration (browning) that occurs on the tissue. This discoloration is due to an enzyme which oxidizes phenolic compounds in the tissue (4). Emphasize to students that the skin of the fruit or vegetable acts as a barrier which keeps oxygen away from the inside tissue. When either cutting or bruising breaks the skin, the oxygen is able to become part of the chemical reaction needed for the oxidation to occur. Immediately chilling the cut pieces will slow the enzyme down. Boiling the cut pieces will destroy the enzyme and prevent any future discoloration of the tissue. Many cooks add an antioxidant that reacts with the oxygen more readily than do the fruit-browning compounds. Antioxidant food additives are vitamin C (found in lemon juice), vitamin E, and synthetic compounds BHA and BHT. Have students list food products where each of the four antioxidants mentioned are found.

*Materials needed:* fruits (apple, banana, etc.), vegetables (potato, eggplant, etc.), lemon juice, and a knife

### *Student Activity*

This is a short but very interesting activity for students. Have students place a Twinkie in a small foil pan. Using a lighter or some other flame source, students should try to burn the Twinkie. Most students will be unsuccessful and find that only a small portion of the Twinkie burns but the entire Twinkie itself does not catch on fire. Have students hypothesize why this occurs. Many will predict that the Twinkie is too moist to burn. After a class brainstorming session on how to dry the Twinkie, suggest to students that the Twinkie could be soaked in some rubbing alcohol prior to burning. When first lit, one will notice a blue flame, characteristic of an alcohol fire. But latter, the blue flame turns to orange and at this point the entire Twinkie is on fire. The heat released while the alcohol burned was able to dry the sponge cake.

*Materials needed:* one Twinkie, small foil pan, a lighter, and rubbing alcohol

### States of Matter

Solids, liquids, gases and plasma make up the four main states of matter. One particularly intriguing state of matter to study is gas. Gases have no definite volume or shape and are highly compressible. Gas particles are in constant random motion, undergoing many collisions with each other and the walls of their container. This results in gas pressure. Air is a mixture of many gases. Air exerts a pressure on the surface of the Earth that is easily measured with a barometer.

### *Teacher Demonstration and Discussion*

Ask students to hypothesize about the relationship between atmospheric pressure and altitude. At high altitudes, atmospheric pressure decreases due to fewer molecules. Since the boiling point of a liquid is defined as the temperature at which the vapor pressure is equal to the atmospheric pressure, the boiling point decreases as altitude increases. Food manufacturers are well aware of this relationship and provide cooking instructions for normal and high altitude conditions. Ask students to bring in food products that have special directions for cooking or baking at higher elevations. Many cake mixes and frozen food packages have such directions.

*Materials needed:* directions from food products (cake mixes, frozen foods, etc.)

### *Student Activity*

Boyle's law states that volume and pressure of a gas are inversely related at constant temperature. Have students investigate Boyle's law by using popcorn. Add some unpopped kernels of popcorn to a large beaker. Cover the beaker tightly with clear plastic wrap. Make a pinhole in the center of the plastic. Place the beaker on a hot plate and observe what happens. Repeat the same steps using kernels of popcorn that have pinholes in the shell like covering (hull). Compare your results. Caution students to allow the beaker to cool before removing the plastic wrap. Students should be able to recognize that inside each kernel there is a small amount of water. When the kernel is heated the water becomes superheated steam. These rapidly moving water molecules cause a tremendous increase in pressure on the hull. Eventually the hull ruptures and the kernel explodes. Emphasize to students that when the hull ruptures, the pressure surrounding the starchy substance inside the kernel is greatly reduced. The water now vaporizes and expands as described by Boyle's law. If holes are punched into the kernel prior to heating the

kernel will not pop. This is due to the fact that steam is able to escape through the holes and there is no build up of pressure inside the kernel.

*Materials needed:* popcorn kernels, a large beaker, plastic wrap, one hot plate, and a small pin

## Solutions

A solution is a homogeneous mixture of two or more substances. A solution consists of two parts. The substance being dissolved is referred to as the solute and the substance doing the dissolving is said to be the solvent. The physical properties of a solution are different from those of the pure solvent. Some of these differences are due to the number of solute particles present in the solution. Colligative properties depend on the number of solute particles dissolved in the solution. Two important colligative properties are boiling point elevation and freezing point depression.

### *Teacher Demonstration and Discussion*

A quick but effective way to introduce colligative properties to students is by adding different salts to water and recording the boiling points of the solution. Using a digital thermometer, record the boiling point of distilled water. Compare this to the boiling point of a variety of solutions. Ask students to estimate what the new boiling points will be prior to actual measurement.

The above demonstration can be adapted to the melting point of ice. Begin by recording the temperature of ice water. Then add some salt to the ice water solution and observe the lower freezing point of water.

*Materials needed:* a variety of solutions ( 0.10 m NaCl, 1.0 m NaCl, 1.0 m AlCl<sub>3</sub>, etc.), distilled water, a digital thermometer, a beaker, and one hot plate

### *Student Activity*

An enjoyable activity for students involving colligative properties is the making of ice cream. Beat one egg in a bowl. Add one-half cup sugar, one and one-third cup of evaporated milk, pinch of salt, one cup of milk and one-half teaspoon of vanilla and mix thoroughly (5). Pour about three ounces of the mixture in to a small zip lock baggie (a small container with a tight fitting lid may also be used). Place the baggie into a larger zip lock baggie (a coffee can with plastic lid may also be used) and add crushed ice mixed with one-half cup rock salt. Remove the air from the bag before closing. Squeeze and shake the bag vigorously for about ten minutes. If using the coffee can, tape the lid securely to the can before shaking or rolling. Students should be able to explain why it is necessary to add salt to the ice. The lower temperature is necessary because ice cream will not freeze at the freezing point of water. It needs a lower temperature.

*Materials needed:* one egg, one-half cup sugar, one and one-third cup of evaporated milk, table salt, one cup milk, one-half teaspoon of vanilla, one small zip lock baggie (small container with lid), one large zip lock baggie (coffee can with lid), crushed ice, and rock salt

## Notes

<sup>1</sup> McGee, Harold. On Food and Cooking: The Science and Lore Of the Kitchen, Simon and Schuster, 1984, p. 192.

<sup>2</sup> <http://www.twinkiesproject.com>

<sup>3</sup> Hillman, Howard. Kitchen Science: A Guide to Knowing the Hows and Whys for Fun and Success in the Kitchen, Houghton Mifflin, 1989, p. 259.

<sup>4</sup> McGee, Harold. On Food and Cooking: The Science and Lore Of the Kitchen, Simon and Schuster, 1984, p. 152

<sup>5</sup> Bath, John B. and Mayberry, Sally C. Kitchen Chemistry, Carson-Dellosa, 1994,  
p. 22-23.

## Teacher Bibliography

Bath, John B. and Mayberry, Sally C. Kitchen Chemistry, Carson-Dellosa, 1994.

A step-by-step series of science books containing simple science experiments for kindergarten through six grade students.

Chem Fax, Flinn Scientific, 1990. This is an excellent source of teacher demonstrations and classroom activities for students.

Gardner, Robert. Science Projects About Kitchen Chemistry, Enslow, 1999. Contains ideas for science projects using various foods or other materials found in the kitchen.

Herron, Frank, Sarquis, J., Sarquis, M., Schrader, and Kulka, Chemistry, D.C. Heath and Company, 1996. This unique textbook includes macro and micro laboratory investigations in each of the chapters. It also has many "Consumer Chemistry" sections throughout the book.

Hillman, Howard. Kitchen Science: A Guide to Knowing the Hows and Whys for Fun and Success in the Kitchen, Houghton Mifflin, 1989. A very enjoyable and easy reading book that answers many common questions dealing with the science of foods and cooking.

LeMay, Beall, Robblee, and Brower. Chemistry: Connections to Our Changing World, Prentice Hall, 1996. This book is used by many high schools as a first year general chemistry textbook. Contains approximately thirty "Chemistry in Action" activities which relate chemistry concepts to the real world.

Loeschig, Louis V. Simple Chemistry Experiments With Everyday Materials, Sterling, 1995. This book is ideal for elementary and middle school students but many activities could also be used at the high school level to demonstrate a specific concept.

Mandell, Muriel. Simple Kitchen Experiments: Learning Science With Everyday Foods, Sterling, 1994. A great book packed full of ideas to teach many science concepts using food products.

McGee, Harold. On Food and Cooking: The Science and Lore Of the Kitchen, Simon and Schuster, 1984. A great reference book dealing with the science of food and cooking. Includes a lot of historical and background information on most food products.

McGee, Harold. The Curious Cook: More Kitchen Science and Lore, Macmillan, 1990. This is the second of two books written by the author. In this book he tries to answer more questions relating foods and cooking. It is written in story form and contains less historical information than the first book.

Phillips, John S., Victor S Stozak and Cheryl Wilstrom. Chemistry: Concepts and Applicatons, Glencoe/McGraw-Hill, 1997. A general chemistry textbook containing "MiniLabs" and "ChemLabs" throughout each chapter.

Wilbraham, Staley, and Matta. Chemistry, Addison-Wesley, 1997. This is the textbook currently being used by the Pittsburgh Public Schools for all general chemistry classes as well as the scholars chemistry classes. It contains many simple activities, sections dealing with consumer chemistry and other helpful topics. A very well written text which students find easy to comprehend.

Williams, Tammy K. Science Experiments Chemistry and Physics, Mark Twain Media, 1995. Science experiments written specifically for middle school students that can easily be adapted to fit any high school curriculum.

Zumdahl, Steven S. Introductory Chemistry: A Foundation, D. C. Heath, 1996. A textbook suitable for high school students. It contains interesting "Chemistry in Focus" sections throughout each chapter.

## **Technology Resources**

<http://www.twinkiesproject.com>

<http://www.uwn.edu>

### **Reading List for Teachers**

ChemMatters, American Chemical Society. This magazine comes with a Teacher's Guide containing background information, classroom activities, suggested student projects, and a variety of other teacher friendly materials.

<http://www.iit.edu/~smile/cheminde.html> This site contains approximately two hundred lessons which may be copied and used in the classroom.

<http://www.usr.sonet.net/usr/jmcauley/demos.html> Many simple science experiments are described in detail at this site.

<http://www.edu/~tholme/ncsw.activities> Fifteen demonstrations that were presented during National Chemistry Week are discussed at this site.

### **Reading List for Students**

ChemMatters, American Chemical Society. This magazine is published four times a year and contains current information on many chemistry-related topics. Most students enjoy reading the articles and doing the puzzle.

<http://www.acs.org> This is an excellent site for students as well as teachers to research current events and meetings related to all aspects of chemistry.

### **Materials Needed for Classroom Use**

Chemicals

aluminum chloride (1.0 M)

crushed ice

ethanol

hydrochloric acid (3.0 M)

rock salt

rubbing alcohol

sodium chloride (10% solution, 0.10 m and 1.0 m)

water (distilled and tap)

Foods

baking powder

baking soda

cake mix

double acting baking powder

egg

eggshells (dried)

evaporated milk

fruits (variety)

iron fortified cereal

Italian salad dressing

lemon

lemon juice

lollipops

milk

popcorn (kernels)

potatoes (moist "waxy" and dry "mealy" )

red cabbage

salt

sugar

turmeric spice

Twinkies

vanilla

vegetables (variety)

vinegar

Equipment

beakers (various sizes)

blender

Bunsen burner

chromatography paper

conductivity tester

dropper

evaporating dish

filter paper

foil pan (small)

funnel

graduated cylinders (various sizes)

hotplate

knife

light bulb (flashlight)

lighter

magnetic stirrer with magnet

metal strips (copper, zinc, etc.)

metric ruler

mortar and pestle

pin (small)

plastic wrap

stirring rod

strainer

test tube and test tube holder

thermometer (digital)

triple beam balance

watch (digital)

wire (fine)

wood splint

zip lock baggies (small and large)

## Appendix

### **Standards**

#### Science and Technology

All students explain how scientific principles of chemical, physical and biological phenomena have developed and relate them to real-world situations.

All students demonstrate knowledge of basic concepts and principles of physical, chemical, biological, and earth sciences.

All students use and master materials, tools and processes of major technologies which are applied in economic and civic life.

All students explain the relationships among science, technology, and society.

All students construct and evaluate scientific and technological systems using models to explain or predict results.

All students develop and apply skills of observation, data collection, analysis, pattern recognition, prediction and scientific reasoning in designing and conducting experiments and solving technological problems.

All students evaluate advantages, disadvantages and ethical implications associated with the impact of science and technology on current and future life.

All students evaluate the impact on current and future life of the development and use varied energy forms, natural and synthetic materials, and production and processing of food and other agricultural forms.

### Communications

All students read and use a variety of methods to make sense of various kinds of complex texts.

All students write for a variety of purposes, including to narrate, inform, and persuade, in all subject areas.

All students analyze and make critical judgments about all forms of communication, separating fact from opinion, recognizing propaganda, stereotypes, and statements of bias, recognizing inconsistencies and judging the validity of evidence.

All students exchange information orally, including understanding and giving spoken instructions, asking and answering questions appropriately, and promoting effective group communications.

### Mathematics

All students compute, measure and estimate to solve theoretical and practical problems using appropriate tools, including modern technology such as calculators and computers.

All students make predictions based upon the collection, organization, analysis and interpretation of statistical data and the application of probability.

### Family and Consumer Sciences

All students demonstrate their knowledge of principles of consumer behavior as a foundation for managing available resources to provide for personal and family needs.