Using Kitchen Chemicals to Identify Key Concepts in Chemistry

Raymond Zanetti

Overview

This unit incorporates enrichment exercises for high school students taking introductory level chemistry. It consists of demonstrations that can be done by the teacher, and hands-on experiments that can be performed by the students. The content is not intended to be a sequential unit of study addressing one major concept, but is comparable to a collection of activities to supplement the existing curriculum and assist students in attaining the established standards. The standards that will be addressed include: determining density, identifying the characteristics of a mixture, separation of a mixture using physical properties of the substances involved, identification of acids and bases by the use of indicators, oxidation-reduction, applying Boyle's and Charles Laws, and identifying chemical changes. I have explained each activity using a description of the lesson followed by how this exercise fits into the existing curriculum. During the course of the school year, these lessons can be used to enhance the core curriculum and facilitate learning.

Rationale

Students often consider first year chemistry to be a difficult subject. They tend to be unfamiliar with many of the core concepts introduced, because these concepts are unique to this science subject. The fact that they experience chemistry every day while doing things in their home kitchen isn't obvious to many students. The kitchen chemicals that they use, or foods that they prepare, are causing chemical changes to occur, but these changes aren't perceived as chemistry. Instead, most changes are recognized as being something unrelated. For instance, bread can be leavened by the use of baking powder. This is one method to make bread ready for baking. Students that I have taught do not identify leavening as a process that uses a chemical change between water and a mixture of an acid-producing ingredient and baking soda to produce carbon dioxide gas. Another example of a chemical change is the denaturing of a protein like casein by a basic solution to produce white glue known as "casein glue." The product is perceived as a device to paste together wood, but the chemistry is overlooked. In the past, when I have questioned different students concerning the chemistry involved with various kitchen substances, many have failed to comprehend that chemical reactions are responsible for the outcome desired. Some students have had middle school or primary school experiences with a red cabbage solution that has been used as an indicator for identifying acids and bases. Many plant pigments can be extracted and then used as indicators. Indicators are weak organic acids or bases that change color when subjected to acids or bases. This color change occurs as the indicator changes from an ionized to nonionized form. Red cabbage extract can vary in the concentration of extracted pigment in solution. There are four pH transition ranges for red cabbage. Beginning at a pH range between 2.5-4.0, with red color indicating acid and violet indicating base. The second pH range is between 6.0-8.5, with acid producing violet color and base producing blue color. A third pH range is 9.0-10.5, with blue indicating acid and green for base. The last range is between pH of 10.5-14.0, with green for acid and yellow for base.

High school students that I have taught over the past twenty-six years have responded in a favorable manner to labs using various chemicals commonly found in the kitchen. I suspect the reason for this is because kitchen substances are familiar items that they have seen or used in the past. These items have names that the students easily recognize. A box of baking soda or bottle of vinegar is more familiar to them than stock reagents labeled acetic acid and sodium bicarbonate. I contend that students will attain content standards in the existing curriculum more readily by the mode of observing chemical or physical changes, while doing experiments that incorporate familiar kitchen reagent materials. It is the familiarity of these substances, and the student confidence in using them, which this unit will employ to enhance learning. Students will make a connection between the skills of properly applying kitchen materials to do a specific task with fundamental techniques commonly practiced in the chemistry laboratory. The focus of this curricular unit will be to incorporate various activities using food and other kitchen substances to enhance the concepts presently taught in the introductory chemistry core curriculum.

Objectives

The intended outcome of this unit is that students will grasp key concepts written in the student syllabus of chemistry-one and achieve higher marks on standardized semester examinations. These examinations will contain questions pertaining to several syllabus standards, which are illustrated by the activities of this unit. Students will use kitchen ingredients to model how reactants are chemically different from the products in a chemical reaction. They will blend together different food items to recognize how to make a mixture, and then learn how a mixture can be separated using physical properties of the substances. They will incorporate the process of making homemade ice cream, using ice and salt, to understand the model of solutes and their effect on freezing point depression. Concepts pertaining to Boyle’s and Charles laws will be reinforced by heating water in kitchen pots with tight fitting lids, and then testing the resistance to lid removal upon cooling. The teacher will demonstrate the concept of density by comparing the buoyancy of diet Pepsi with Pepsi that contains sugar. Students will explore the concept of density by watching a simple test that identifies fresh eggs from old eggs. They will use a similar method to distinguish "waxy" type potatoes from "mealy" type potatoes, based upon the greater buoyancy of the less dense potato in brine solution. Potatoes will also be used to demonstrate the oxidation/reduction reaction of iron in the "stem-end blackening" process that occurs while cooking in boiling water. The students will observe a neutralization reaction between a base and acid when baking powder is dissolved into water with the accompanying generation of carbon dioxide gas (simulating the rising of bread dough). An acid/base indicator will be made using cabbage, and then students will use the indicator to test various kitchen chemicals for acidity. Making a polymer and examining its properties will reinforce the concept of polymer formation.

Strategies

Many techniques will be included to help students achieve the objectives and attain the goal of higher achievement on the semester examination. Each student activity or demonstration will be thoroughly examined in pre-lab lecture notes given by the instructor. During the lab activity, photographs will be taken of the student participants doing the lab. A follow-up discussion will occur after each lesson to insure that everyone understands the concept being demonstrated. Short quizzes will then be administered with questions similar to those that will be given on the semester exam. Students will be encouraged to do independent research on each concept presented and write a three-page report that includes possible modifications to improve the original activity, or newly designed procedures to demonstrate the principle being tested. Each lab group will take a turn at creating a learning-center poster board that describes what was done during one of the activities, and these poster boards will then be displayed in the classroom. The learning centers will include an introduction to the concept being examined, and an evaluation of what was learned by doing the activity.

Classroom Activities

Teacher Performed Demonstrations

Demonstration #1

Students must be introduced to the concept of density as the ratio of mass per unit of volume, and given quantitative examples for calculating the densities of various substances. After students satisfactorily do calculations to solve for each variable of the density equation (density, mass, or volume), the instructor will demonstrate how substances of greater density displace those that are less dense. An explanation of how density relates to buoyancy will be provided before doing this demonstration. The teacher will then take two twelve-ounce cans of Pepsi Cola and place them into a battery jar filled with water. One of the cans will be Diet Pepsi and the other can will be Pepsi containing sugar. The can of diet cola will float in the water and the Pepsi with sugar will sink to the bottom of the battery jar. To ascertain how much sugar is in the can that sank to the bottom, the instructor will add consecutive teaspoonfuls of sugar to the top of the Diet Pepsi can. This needs to be done very carefully so that none of the sugar slides off from the top of the can. A substitute method for adding sugar so that none of the sugar falls off the top of the can is to use sugar bags instead of teaspoons of sugar grains. Prior to doing this demonstration an average mass per sugar bag should be determined by the instructor. Students will then calculate the additional mass of sugar needed to sink the Diet Pepsi can, and use this data when comparing the density and specific gravity of the sugar-containing Pepsi Cola and Diet Pepsi.

Demonstration #2

An additional demonstration to illustrate the concept of density is the simple test for determining an older egg from a fresh egg. In this experiment the instructor has two eggs that look alike, but one egg is much older. Both eggs are placed into a large bell jar that contains a saturated solution of salt water at the bast of the jar, and fresh water at the top of the jar. The fresh egg will sink tot the bottom of the bell jar because it is denser than the surrounding water. The old egg will float because it is less dense than the water. The eggs can be weighed to find their masses, and then submerged in water to determine their volumes. The water displaced when an egg is submerged will equal the volume of the egg. Knowing the mass and volume of each egg will allow students to determine the density for each egg. The older egg will have a lower numeric value for density.

Both eggs can then be carefully broken apart to determine why the older egg is less dense. The students will see that the older egg has a gas pocket at one end of the egg, but the fresh egg does not have this gas pocket and therefore has a greater mass per unit of volume.

Demonstration #3

This demonstration as provided by McCamish, concerns the generation of carbon dioxide gas that occurs when baking powder chemically reacts in water (711). In this demonstration the student will see evidence of a chemical change by the production of a gaseous product. The instructor will begin by placing five grams of baking powder into a Buchner flask (See Figure #1). This flask is fitted with a dropping funnel that contains 100 ml of water. Plastic tubing connected to the arm of the flask will lead to a bell jar that is half-filled with water. Inside of the bell jar is an inverted 1 Liter graduated cylinder that is completely filled with water. The tubing from the Buchner flask should be positioned so that gas generated in the flask travels through the tubing and then is collected inside of the graduated cylinder. The carbon dioxide gas will displace the water in the graduated cylinder and the volume of gas generated can be easily measured. As water from the dropping funnel is slowly added to the baking powder in the flask, carbon dioxide gas is generated by a neutralization reaction between the tartaric acid and sodium bicarbonate, as both chemicals become aqueous. The amount of gas generated will occur at a slightly greater rate than it would in batter during mixing, because the solution allows faster contact between the acid and base. The neutralization between an acid and base in solution is the same type of reaction that occurs in batter, with carbonic acid decomposing into carbon dioxide gas and water vapor. Single-acting powders or double-acting powders can be used to leaven the batter mix. Trapped gas collecting within the graduated cylinder can easily be measured in time intervals to determine the rate of progress of the reaction. Students can stoichiometrically determine the theoretical amount of carbon dioxide that should be produced by five grams of baking powder, and then compare this with the actual amount prepared experimentally. A good follow-up exercise is to have students calculate the amount of experimental error that has occurred, and then write a list of reasons for what might have caused this error. To verify that the collected gas is indeed carbon dioxide, the instructor will remove a sample of the trapped gas for testing. Removal can be accomplished by the use of rubber tubing attached to a syringe. The tubing is placed into he trapped gas of the inverted graduated cylinder, and a sample of gas is then drawn into the syringe. The sample gas is then bubbled into a test tube filled with limewater to check for formation of a precipitate, thus indicating the presence of carbon dioxide gas.

Demonstration #4

Hemmingsen provides a colorful demonstration that illustrates the concept of using an indicator to test for the acidity of a substance ("screen 1"). In this demonstration a red cabbage is cooked in water until the water becomes a light-purple color. This purple colored water is the indicator solution that is used for testing the acidity of three different substances. Indicators are usually weak organic acids or bases that have distinctly different colors in ionized or nonionized forms. In acidic solutions the indicator will have a different color than when in the presence of a basic solution. The first substance tested is distilled water. Expect the mixture of cabbage indicator to remain purple in color because distilled water is neutral and will only dilute the indicator. The next substance to be tested is sodium bicarbonate (baking soda). Three tablespoons of baking soda should be dissolved in a half-filled 400ml beaker of distilled water. Add equal parts of cabbage indicator and note the color change. A blue color change indicates that the mixture is a basic solution. Try this same procedure to make a solution using 5 tablespoons of vinegar in 400 ml of distilled water, and then add the cabbage indicator. The red color produced indicates that the vinegar solution is acidic.

Demonstration #5

A demonstration that illustrates the concept of freezing-point depression is the making of homemade ice cream. This lab requires the use of an ice cream making mechanism; either motor driven, or hand crank model (Bryant, sec.1). The ice cream will be prepared within a 45-minute lab period. The ingredients needed are as follows: 2-L table cream, 350 ml instant skim-milk, 450 grams sugar, one 7 gram package of gelatin, one medium egg, and 10 ml vanilla. The mix will separate into two equal portions and then be stored over-night in two 1-gallon containers to allow for aging. Aging the mix improves the mixing ratio of air to ingredients. This aging should take place in a refrigerator. On the next day of class the vanilla flavoring is stirred into both containers. One of the containers is cooled in a freezer bucket containing brine slurry made from 500 grams of rock salt and 5 Kg of crushed ice. The dasher of the ice cream machine will blend and stir air into the mix as salt is added to the crushed ice in the freezer bucket. Additional water is slowly poured over the salt-ice mixture until the ice cream is solidified. The temperature of the brine is measured at the time that the ice cream freezes solid. The other batch of mix will then be placed into 5 Kg of crushed ice, without the addition of rock salt. The dasher blends this batch in the same manner as the first too add air to the mix. After several minutes, the students will see that the second batch does not solidify. A temperature reading is taken after several minutes of blending have elapsed. The final step is to add 500 ml of rock salt to the freezer bucket of the second batch, and then blend the mix until the ice cream freezes. The students can do the activity of making a milk shake by using the ice cream produced during this demonstration.

Demonstration #6

This demonstration will apply Charles and Boyle’s Laws to the behavior of a pot lid upon a heated pot of water. Wilbraham, Staley, and Matta define Charles’s Law as the volume of a fixed mass of gas being directly proportional to its Kelvin temperature if the pressure is kept constant. Boyle’s Law is defined for a fixed mass of gas at constant temperature, as the volume of the gas varying inversely with pressure (861). In this demonstration the instructor must have a pot that has a very tight fitting pot lid. The pot is half filled with water and placed upon a hot plate to heat. The pot lid is then placed upon the heating pot. Heat the pot until the water starts to boil. Remove the lid while the water is boiling to show students that the lid comes off easily. Return the lid to the pot and continue boiling for two minutes. Turn off the heat and remove the pot to a cookie tray. Slowly pour ice-cold water over the top of the pot lid. After the pot lid cools to the touch, gently pull upward on the handle of the pot lid. The lid will resist being pulled from the pot. This can be explained using Boyle’s and Charles’ Laws by relating temperature change and pressure change to the internal volume change of the vapor inside the pot. The lid is easily removed while vapor pressure within the pot is high, due to boiling. When cooled, the vapor pressure decreases and a partial vacuum is created within the pot. During cooling some of the water vapor will condense. The water vapor will continue to condense until the pressure of the vapor is equal to the vapor pressure of water at the new temperature. This lowering of temperature and vapor pressure causes a near vacuum, and will result in some difficulty when trying to remove the lid from the pot. The atmospheric pressure surrounding the cool pot becomes higher than the pressure within the pot, thus resulting in the resistance to removing the pot lid. A more dramatic follow-up demonstration is to use one-pint size steel can with a screw type lid, instead of a pot. A ¼ cup of water is heated within the metal can until boiling. Wait until steam comes out of the opening of the can, and then screw the lid of the can into place. Make sure that the screw lid is tightly fixed onto the can. Remove the can from the heat source and allow it to air cool for several minutes. As the internal temperature within the can decreases, water vapor will condense back into liquid. This decrease in temperature results in a lower internal pressure than the ambient atmospheric pressure surrounding the can. Increasing external pressure pushes against the can, thus causing it to crush inward. Placing the hot can into a bucket of ice water dramatically increases crushing of the can.

Student Preformed Activities

Activity #1

It's a good idea to have some kind of student activity to follow behind the teacher-demonstration. I have found that students have their pumps primed during the teacher led activity and can't wait to get into the act of doing hands-on chemistry. After doing the density demonstrations, have your students distinguish between "mealy" versus "waxy" potatoes. These potatoes have distinctly different physical properties, in that, "mealy" potatoes tend to float in brine and "waxy" potatoes tend to sink. The density can then be determined by measuring the mass and volume for each potato. Volume can be measured using a method of water displacement, where each potato is submerged in water and the resulting volume change represents the space taken up by the potato. Have students suggest a possible reason for the difference in the density of these potatoes.

Activity #2

A follow-up activity to the making of ice cream demonstration is having students make a milkshake. This activity will reinforce the concept of a mixture. The combination of milk with homemade ice cream and fruit is a good example of a heterogeneous mixture. The ingredients are placed into a blender and mixed together until a delicious drink is ready for consumption. The students are then required to describe the appearance of this mixture before drinking the product.

Activity #3

To reinforce the concept of how an indicator can be used to distinguish between an acid and a base, the students use cabbage juice indicator solution to test various kitchen chemicals. The students work in groups of four to investigate color changes that occur when cabbage juice indicator is added to the following substances: milk of magnesia (magnesium hydroxide), salt, sugar, lemon juice (citric acid, $C_6H_8O_7$), tonic water, and baking powder. Each group is given one substance to test. On the chalkboard the results from each group is recorded. The students will then write a short paragraph in which they group the substances into the major categories of acid, base, or neutral. After grouping the materials into categories, the students will predict what they think the outcome will be if substances from different categories are mixed together. The final step of this exercise is for the students to go back to the lab and mix together the substances they wrote about in their paragraph and test the resulting mixture with the cabbage indicator solution. A listing of their results will be shared with other members of the class by writing the outcomes on the chalkboard.

Activity #4

A simple activity can be performed by students to test for the solubility of a gas in solutions at different temperatures. This requires the use of a can of soda pop and a plastic bag. Before doing this exercise, be sure that students have seen the demonstration involving the generation of carbon dioxide gas by adding water to baking powder. It is important that they are familiar with the testing technique for sampling carbon dioxide gas, and how bubbling carbon dioxide gas through limewater will produce a precipitate. The students will form into separate lab groups and begin by covering each soda can with an empty plastic bag. The purpose of the bag is to capture and escaping gas generated by their can. Make sure that the students start with the bag completely collapsed and void of any air. They will then attach the bag to the soda can by wrapping a rubber band around the top lip of the can. It is a bit tricky to pull up the lift top tab through the attached bag, but it can be made easier to lift by having students prepare the tab ring by bending it slightly upward before attaching the bag. As gas escapes from the can, the bag will inflate in size. Assign each lab group a different temperature for generating gas. The range of temperatures is 5 ^{o}C through 95 ^{o}C. Each group will control the specified temperature of their can by the use of a water bath. They will place the unopened can into the temperature specific water bath and wait five minutes before opening the tab. This will allow for the contents of the can to adjust to the temperature of the water bath. After removing the tab, gas collection will be made for two minutes. Each group will measure the amount of gas generated by carefully removing and sealing the bag. The contents of the bag can be released under an inverted graduated cylinder that has been filled with water. The amount of gas is then measured by how much water is displaced within the cylinder. Each group will report their data to the class by writing it on the chalkboard. Students will then graph the results for temperature versus volume of gas generated. The cans at higher temperatures will release more carbon dioxide gas into their bags than cans at lower temperatures. Using a syringe fitted with a length of plastic tubing, extract a sample of collected gas from the graduated cylinder. Place the tubing into a test tube containing limewater solution. Students will then inspect the solution for the formation of precipitate formed by passing carbon dioxide gas through limewater.

Activity #5

As stated by McGee, a lab that can be done that combines the concepts of acid/base reactions with oxidation/reduction involves the use of a potato (193). In this lab a potato is cooked in boiling water for 40 minutes. After being removed from the water and allowed to cool, the end of the potato that has been connected to the plant will produce a dark gray color. This region is called "Stem-end Blackening," and the reason for this color change is that iron ions in the potato are experiencing a "redox" reaction. During cooking ferric (Fe^{+3}) ions are formed from ferrous

(Fe^{+2}) ions by the gaining of electrons from phenolic substances in the region where darkening has occurred. This "Stem-end Blackening" is pH sensitive, where neutral and basic cooking solutions produce a greater amount of blackening effect, and acidic water causing little to no color change. With this is mind; the students will cook potatoes in water that varies in pH range to see what effect this has on the amount of oxidation/reduction occurring. Students will work together in groups of four, and will be assigned a specific pH for the cooking water in their 1000 ml beakers. Assign each group a different pH. The entire class-range will be from pH 3-11. All potatoes will be approximately the same size and will be cooked for 40 minutes. Baking soda will be used as a sweetening agent to make the basic cooking solutions, and cream of tartar will serve in making the acid solution. Universal indicator paper will be used to check that each solution is in the specified pH range.

Activity #6

An activity that students can do within 25 minutes is to make ice cream using two zip lock bags. Each student will need the following items: one-quart size zip lock bag, one-snack size zip lock bag, one cup of milk (any type), one half-teaspoon of vanilla, one teaspoon of sugar, two cups of crushed ice, a tablespoon of rock salt, and a plastic spoon. To the snack size bag add a cup of milk, and mix in the sugar and vanilla. Into the quart size bag place the two cups of ice and the rock salt. The small snack size bag is then placed into the larger quart size bag. Students must be reminded to carefully close both bags using the zip lock mechanism. Each student must then shake the bag system for 5 minutes until the mix hardens into ice cream.

Activity #7

This activity allows students to make glue from ordinary milk and vinegar. It is known as "casein glue" because it is commonly made from the bones of horses and cows. Each student will need the following ingredients; one quarter cup of milk, one half teaspoon of vinegar, a dropper pipette, a 400 ml beaker, a hot plate, a 20 cm square of cheese cloth, one-half teaspoon of ammonia, a glass stirring rod, and two wooden splints. The students will work in pairs to prepare the casein glue. Start by heating the milk in the beaker over a hot plate. The milk should not be allowed to boil. Slowly add drops of vinegar to the heated milk using the dropper pipette. The milk will begin to form into a yellowish liquid (whey) and a white solid (curd). The students need to filter the curd from whey using the cheesecloth. One method to separate the curd from whey is to attach the cheesecloth by placing it over the beaker and then wrapping a rubber band over the cloth to hold it in place. The mouth of the beaker is then tipped to allow whey to filter through the cheesecloth. Another method is having one student securely hold the corners of the cheesecloth while the other partner pours the contents of the beaker into the center of the cloth. Either method should be done over a lab basin. The curds collected in the cheesecloth are casein. These curds should be placed onto a paper towel and allowed to dry. It can be mentioned to students at this time that curd is a substance useful in the making of cheese. Tell students not to eat the raw curd because it represents only an intermediate step in the production of consumable cheese. After drying, the curds are placed back into the beaker. The students will then add one-half teaspoon of ammonia solution to the curds and slowly stir with a glass stirring rod. When the mixture becomes thick and creamy in texture, rub the casein glue onto the two wooden splints and join them together. Allow the glue to dry for several hours to demonstrate the effectiveness of this glue as a potential bonding agent for wooden parts being joined together.

Activity #8

Another experiment that uses kitchen chemistry to illustrate a chemical reaction is the production of carbon dioxide gas to make "honeycomb." The students will mix one-teaspoon of butter with one cup of sugar in a large saucepan. This mixture is heated over a hot plate until boiling. The mixture is heated until it becomes a dark golden color. Allow the mixture to cool for two minutes. Then blend 2 tablespoons of vinegar and ¼ teaspoon of baking soda into the mixture. A reaction between the vinegar and baking soda will generate carbon dioxide gas bubbles and cause a froth to form. The contents of the saucepan are then poured onto a cookie tray that has been greased with butter. Give the froth several minutes to cool, and have students make observations of the resulting product. After cooling the students can cut the honeycomb into pieces for eating.

Activity #9

The formation of a polymer can be achieved by using a recipe for the making of Gloop (Ross, 1995). In this activity students were given the following ingredients; 2 cups of white school glue, 1-½ cups of water at room temperature, 1 cup of warm water, and 3 teaspoons of borax powder. The white glue was diluted with the 1-1/2 cups of room temperature water in a large bowl. Be sure that the students stir this mixture until it becomes thoroughly mixed together. In the cup of warm water add 3 teaspoons of borax and blend them together using a glass-stirring rod. Slowly pour the borax solution into the diluted white glue and stir constantly for two minutes. The students will need to use their hands to knead the Gloop mixture until it becomes smooth. When the Gloop no longer feels sticky, it is done. Have the students pull upon the Gloop to see how it stretches. This action is the result of the polymer bonds that have formed between the molecules. Food coloring can be added to the starting white glue mixture if color is desired.

Activity #10

A useful method for separating a mixture is the technique of paper chromatography. By using the physical properties of molecular weight, and intermolecular forces of attraction, several substances making up a mixture can be separated. Students will prepare paper chromatographs of four different food colorings that contain FD&C dyes. The materials needed by each student include; 4 food colors (green, yellow, blue, and red), one coffee filter for a drip coffee maker, 4 tooth picks, and one 250 ml beaker. The students will first need to cut the coffee filter into a rectangular shape that measures three inches by four inches. Each student will need a small amount of food coloring for each color being tested. I recommend a tiny spot plate be used for the purpose of containing the different food colors. A dropper pipette is used to transfer the different food colors from the squeeze dropper bottle to the spot plate. Only 2 drops of the colored liquid are needed for each student. Into each well of the spot plate the student can put a toothpick to collect up some of the food color. It is important that the toothpick be pointed on the side that is used as the applicator for the food coloring. A tiny dot of food coloring will give a better final result. Have the students lightly crease one side of the coffee filter paper, approximately 2 cm from the edge of the four-inch length. This crease line will serve as the starting position for each of the food colorings that are being tested. The different food colors should be placed 2 cm apart from each other on the creased line, and then the filter paper is unfolded until the paper appears flat with the crease is no longer evident. Into the beaker, pour 1 cm of vinegar. The filter paper is then placed into the beaker so that the side of the paper with the four dots enters the vinegar. The dots of food coloring will be 1 cm above the surface level of the vinegar. Cover the beaker with a piece of aluminum foil and allow the vinegar time to move up through the filter paper to make contact with the food color dots. As the vinegar works its way up the filter paper by capillary action, the dots will start to move upward with the rising level of the vinegar. Because these different colored dots are made up of different dyes, the dyes will begin to separate into identifiable regions with a different color. These dyes have different structures and weights, and will not be able to travel through the filter paper at the same rate of speed. After several minutes the mixtures of dyes will spread out into a colorful spectrum of different colors. Do not allow the vinegar to completely reach the top of the filter paper before removing the paper from the beaker. The filter paper is then removed from the beaker and allowed to dry. To make the lab more interesting, a second test can be made using one of the four food colors as an unknown. The students will perform the same technique using only the dot of an unknown color on a new piece of filter paper. When finished, they can then compare this result to the chromatograms of the four known food colors. One of the chromatograms will exactly match the chromatograms of the unknown.

Activity #11

After students have become familiar with the use of paper chromatography to separate the components in a mixture (see activity #11), have them do the same technique using jellybeans as the test sample. Start with four different colored jellybeans. Each jellybean will have the outer colored coating scraped off with a small knife. Use a mortar and pestle to crush the coating into a powder, and then add 2 ml of distilled water to dissolve the powder. The resulting colored solutions will be used as the dots being tested on the filter paper. Do the separation process using the same method as with the food colorings, except use water instead of vinegar as the traveling medium at the base of the beaker.

-

-

Student Reading List

Bryant, Janice. "Homemade Ice Cream." Dairy Science and Technology. California. U. of Guelph. 1980 <http://www.foodsci.uo

Guelph.ca/dairyedu/homepage.html>
This website provides useful information concerning the process of making ice cream.

Hemmingsen, Sherry. "Colorful Solutions from the Kitchen: Your Turn."

Project Primary: Chemistry. Ohio Wesleyan U. June 1997
<http://www.owu.edu/~Mggrote/pp/chemistry/kitchen/solutions.html>

A good source of facts about red cabbage indicator solution is provided by this resource.

Hillman, Howard. Lisa Loring, and Kyle MacDonald. Kitchen Science:Revised Edition. Boston, MA: Houghton Mifflin. 1989
This resource contains general information about kitchen chemistry.

McCamish, Malcolm. "The Rise of Self-Rising Flour: A Recipe for Success." Journal of Chemical Education. 64 (1987): 710-12.

Many facts about leavening agents are discussed in this article.

McGee, Harold. On Food and Cooking: The Science and Lore of the Kitchen. New York: Charles Schriber's Sons. 1997.

This book provides a comprehensive study of food composition and the chemistry of food preparation.

Sloan, Barbra. "The Experiments." Lolly Chromatography. Laverton Secondary College.
<http://members.ozemail.com.au/~macinnis/scifun/kitchem.html>

A discussion of paper-chromatography is provided by this website.

Wilbraham, Anthony. Dennis Stanley, and Michael Matta. Chemistry:Expanded Fourth Edition. Menlo Park, CA: Addison-Wesley Publishing. 1997.

This textbook provides information on general concepts of introductory chemistry.

Wilbraham, Anthony, et al. Everyday Chemistry: Expanded FourthEdition. Menlo Park, CA: Addison-Wesley-Publishing. 1997.

A resource to accompany the textbook, Chemistry: Expanded Fourth Edition.

Materials List

-

Nonconsumable

Battery jar

Beakers (250 ml, 400 ml, 1000 ml)

Blender

Buchner flask (250 ml)

Standard chromatography paper

Cookie tray

Dropping funnel (250 ml)

Dropper pipette

Gas hosing

Glass stirring rod

Graduated cylinder (1 L)

Hot plate

Mortar & pestle

Pot & lid (2 quart)

Syringe (40 cc)

Saucepan

Thermometer

Toothpicks

Wooden splints

Consumable

Aluminum foil

Ammonium solution

Baking powder

Baking soda

Butter

Borax powder

Cabbage (red)

Cheesecloth

Chromatography paper

-

-

-

-

Consumable

Coffee filters

Diet Pepsi

Distilled water

Eggs

Food colors (blue, green, red, yellow)

Fruit (various)

Ice

Jellybeans (various colors)

Lemon juice

Limewater

Milk

Milk of Magnesia

Pepsi

Plastic storage bags (1 quart size)

Potatoes

Rubber bands

Salt

Sugar

Tonic water

Universal indicator paper

Vinegar

White glue

Appendix-Content Standards

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

All students demonstrate knowledge of basic concepts and principles of chemistry.

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, prediction and scientific reasoning in designing and conducting experiments and solving technological problems.

Works Cited

Bryant, Janice. "Homemade Ice Cream." Dairy Science and Technology.

California.U. of Guelph. 1980 <http://www.foodsci.uoGuelph.ca/dairyedu/homemade.html

A good resource for understanding how ice cream is made.

Hemmingsen, Sherry. "Colorful Solutions from the Kitchen: Your Turn."

Project Primary: Chemistry. Ohio Wesleyan U. Jun. 1997 <http://www.owu.edu/~Mggrote/pp/chemistry/kitchen/solutions.html>.

A website that explains how to make and use red cabbage indicators.

McCamish, Malcolm. "The rise of Self-Rising Flour: A Recipe for Success. Journal of Chemical Education. 64 (1987):710-12.

This article gives a detailed description of leavening agents.

McGee, Harold. On Food and Cooking: The Science and Lure of theKitchen. New York: Charles Schriber's Sons. (1997):193-94.

A book with detailed information of chemical reactions in foods (e.g. redox reactions in potatoes).

Wilbraham, Anthony. Expanded Fourth Edition. Menlo Park, CA: Addison-Wesley Publishing. (1997): 294-97.

A useful book for describing general concepts in chemistry.