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Sweet Twinkie, Density and Sugar Chomping Yeast: A Look at Physical and Chemical Reactions in the Kitchen

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by Roisin A. Macdonald

Introduction

I teach seventh and eighth grade science at Betsy Ross Arts Magnet Middle School in New Haven. Betsy Ross is an inter-district middle school with students not only from New Haven but also from surrounding suburban towns. Being an inter-district magnet school has led to a diverse student population, the majority of which are living within New Haven City limits (i.e. approximately 25% within the school's neighborhood and 50% from other areas of New Haven); the remaining 25% are from suburban towns. As my school is an Arts Magnet School it makes sense that many of the students are creative and active, more so than normal. This attribute can be advantageous for me as teaching science through example and hands on activity are what I strive to do. My students, thus far, have done very well with interactive laboratory experiences and project based assessments. Whenever possible, I try and relate the content being taught to the student's everyday experiences.

The mere thought of science class frightens the average middle school student. There are, of course, the exceptions. It is more likely that even if a student finds science interesting, and therefore appealing at some level, they may not be willing to admit it. Throw the word chemistry into the mix and shivers run down their spines! The unit Sweet Twinkie, Brownies, Density and Sugar Chomping Yeast: A look at physical and chemical reactions in the kitchen enables me to present material regarding chemical and physical properties as well as basic chemical reactions from the viewpoint of food and baking. Overall, I do not believe that students would associate food with chemistry since chemistry is a mysteriously hard subject that the average person can never comprehend. There must be some secret to discovering and understanding complex concepts of chemistry, isn't there? The answer, of course, is no. Chemistry is in action every time we take a bite of an apple, make toast, scramble eggs, pop open a can of soda; the examples are endless.

My unit is intended for a heterogeneous group of 20-25 seventh graders and will be initiated with a discussion of how chemistry is an important part of all our lives, every day we take part in an insurmountable number of chemical reactions. Making initial connections by having students discuss what their morning was like and how chemistry played an important role will be the goal of the first lesson. Before honing in on the intended food subject area we will activate prior knowledge of molecules and how they move dependant on the state of matter (class activity: Movin' Molecules). An introduction to chemical and physical properties is presented with

the concluding portion of the lesson illustrating how mixing/melting ingredients are examples of physical changes while baking those mixed ingredients culminates a chemical change. Students explore the concept of density, determining the density of a Twinkie utilizing both the geometric and water displacement method for determining volume. As this lesson pertains to baked treats, the use of leavening agents used to make these treats light and fluffy is covered, we will review the four types of leavening agents. The culminating lesson of this unit allows students to examine the production of CO₂ during the fermentation process of yeast feeding on sugar water.

Objective

After completion of this unit students will be able to define the three most common states of matter (solid, liquid and gas), as well as how matter is categorized into either mixtures or substances. Students will explore the concept of density by determining the density of a Twinkie, they will be able to calculate volume both geometrically and by water displacement method. Students will also identify and differentiate between chemical and physical properties as well as chemical and physical changes that take place when ingredients are mixed and finally baked making Monkey Bread. Lastly, students will experience why yeast has been utilized for thousands of years to raise bread dough through the production of carbon dioxide when yeast feeds on sugar water.

Background

The intent of this unit is to have students explore the chemical and physical properties and changes that occur in the kitchen. Prior to proceeding with the intended subject there are a few things that need to be addressed and reviewed, the first of which is matter.

Matter

What is matter? By definition, matter is anything that has mass and takes up space. Everything around us, including ourselves, is made of matter. Matter can be classified into two primary categories: pure substances and mixtures. A pure substance cannot be separated by any physical means, pure substances are either elements like oxygen (O₂), hydrogen (H₂) and gold (Au) that contain only one type of atom, or compounds which contain two or more elements joined together in a definite proportion, like water (H₂O), carbon dioxide (CO₂) or sugar (C₆H₁₂O₆). Elements cannot be broken down by physical or chemical means. Compounds can be decomposed or separated by chemical means, for example, in the process of electrolysis water molecules are broken down into hydrogen and oxygen atoms. Baking powder, which is baking soda (NaHCO₃) plus a weak solid acid (cream of tartar), when added to warmed water releases carbon dioxide gas CO₂ which creates the light consistency in many baked products.

Mixtures on the other hand can be separated by physical means. Mixtures contain two or more pure substances and can be further categorized by whether or not the substances are uniform within the mixture itself. A mixture is said to be homogeneous if the composition is uniform (components are not easily seen).

Air, sugar water, stainless steel are all examples of homogeneous mixtures. A mixture is said to be heterogeneous if the substance composition is not uniform, that is you can see the components of the mixture. Plywood, salad dressing, granite, cinnamon and sugar are all examples of heterogeneous mixtures.

Another common way of categorizing matter is by its physical state, (commonly referred to as the phase of matter) that is, a solid, a liquid, gas, plasma or the most recent state of Bose-Einstein condensates. For the sake of simplicity, we will focus on the first three, most common states: solid, liquid and gas.

All matter is composed of molecules, it is how these molecules are arranged and move in reference to one another that determines the substances physical state. In the gaseous state the molecules are free to move about, that is the gas molecules take on no definite shape or volume. The molecules within a gas have no specific arrangement and are well separated. Due to the space between the molecules of a gas it is easily compressed. A substance that is in a liquid state has molecules that are closer together, but still in a random pattern, the substance still has no definite shape. Like gases, liquids take on the shape of the container holding them. The molecules in a liquid can easily slide past one another but are much closer together compared to a gas. Finally, a solid has molecules arranged so that the solid has a definite shape and volume. The molecules are arranged in a more rigid pattern and vibrate only slightly; there is little room for the molecules to move from place to place as in the liquid and gaseous states. A solid is not easily compressed since its molecules are naturally close together and there is little room left for compression.

Let us take for example, water molecules. We all know water can easily exist in all three states dependent upon the temperature, a gas as steam, as liquid water, and as a solid, ice. Figure 1 illustrates the molecular structure of the water molecules in each state. Figure 1a, depicts the water molecules in a gaseous state, the molecules have plenty of space between them and are free to move about. Figure 1b shows the molecules of liquid water, note the molecules are more closely arranged, you can see how the molecules are able to slide past one another but are confined to a specific volume and take on the shape of the container. Lastly, Figure 1c illustrates how the molecules of solid ice are arranged in a definite pattern, the ice molecules can only vibrate in place not slide past one another, as in the liquid state or bounce off each other as in the gaseous state. Water in the solid state has a definite shape and volume.

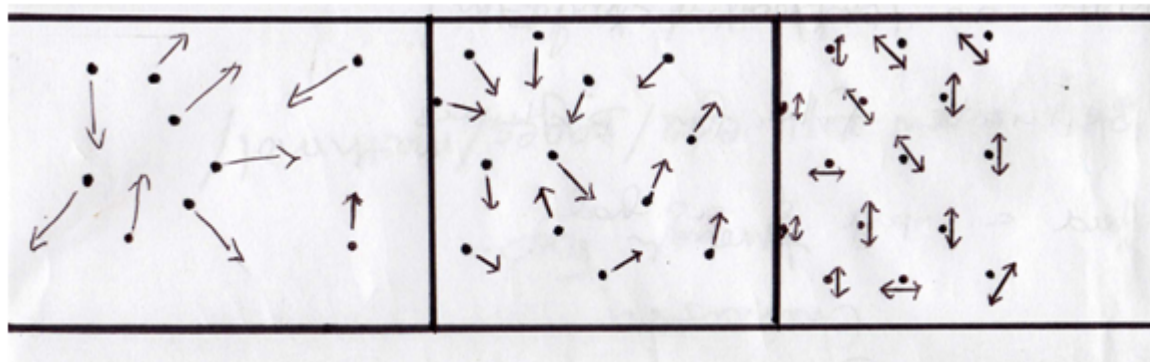


Figure 1a: Gas

Figure 1b: Liquid

Figure 1c: Solid

Lesson one of this unit, Movin' Molecules, allows students to see firsthand how the movement of the molecules becomes more restrictive as they move from a simulated gaseous state down to a simulated liquid state and finally confined to a small area depicting the solid state.

Physical and Chemical Properties

The next item that needs to be discussed is the difference between physical and chemical properties of matter. First, let's establish the fact that a substance's state of matter is a physical property. A physical property must be easily observed and cannot culminate in a new substance, i.e. the composition of the substance remains the same. Physical properties are used to describe the substance. A substance's size, color, shape, and texture are all physical properties since they are used to describe that substance. Other examples of physical properties are the substance's melting point, boiling point, viscosity, solubility and density. The main characteristic to remember regarding physical properties is that the substance does not change; water is still water whether it is a solid, liquid or gas, its density is always one gram/milliliter (at room temperature), its melting point is always zero degrees Celsius and its boiling point is always one hundred degrees Celsius (at standard atmospheric pressure).

One physical property middle school aged students have trouble grasping is density. Density is defined as mass of an object per unit volume. The density of water is one gram per milliliter (at room temperature). Densities are often shown as a comparison to water, that is either the substance is more dense (density >1 gram/milliliter) and therefore sinks in water or less dense compared to water (density 1 gram per milliliter) which will naturally float. This concept can be demonstrated with a piece of balsa wood (less dense) and a rock (more dense) in water. The table below lists the density (1,2) of some common substances:

Balsa wood 0.2 g/cm³

Milk 1.03 g/cm³

Lead 11.0 g/cm³

Iron 7.8 g/cm³

Ice (0°C) 0.92 g/cm³

Water (20°C) 1.00 g/cm³

Gold 17.2 g/cm³

Silver 9.3 g/cm³

Use of the example above in the classroom may lead to the question, "if water and ice are the same substance, why does ice float in water?" The answer is quite simple, the structure of the ice molecules are arranged as a crystal lattice, the ice molecules within the lattice take up more space compared to the molecules in liquid water. In other words, as water freezes it expands, the crystal lattice has more volume (takes up more space), so that a liter of ice weighs less than a liter of water. As noted above, the density of ice is slightly less than the density of water; the heavier water displaces the lighter ice so it floats. This is the reason why water in rivers and lakes freeze at the top but is still liquid underneath, the less dense ice floats on the top.

Determination of Density using a Twinkie

Density is calculated by measuring the mass of an object and then determining the volume either through direct measurement (by liquid displacement) or geometrically, through mathematical measurements and

calculations. Determining density is then a simple calculation of mass divided by volume. In keeping with our theme of food, lesson two is how to determine the density of a Twinkie, as a side bar the students can also calculate how much of the Twinkie is actually air (3).

The mass of the Twinkie is determined using a triple beam balance or a laboratory digital scale. The unit customarily used for measuring mass is grams. The shape of a Twinkie is nearly rectangular prism; therefore we will utilize the mathematical formula for the volume of a rectangular prism to determine the volume of the Twinkie:

$$\text{Volume} = \text{length} \times \text{height} \times \text{width} = \text{cm}^3$$

The second method used to determine volume is the water displacement method. This method can be traced back to around 250 BC when the Greek mathematician, Archimedes was assigned the task of determining if King Heiro I of Syracuse was being swindled out of his gold by his goldsmith. As the story goes, The King Heiro I of Syracuse noted his goldsmith seemed to be living a lifestyle much higher than he was being paid. King Hiero suspected the craftsman was stealing his gold by substituting silver when crafting his royal crowns. Archimedes knew that gold was heavier than silver so all he had to do was to determine the density of the two crowns. Massing the crowns was no issue but how was he going to get the volume. Archimedes could melt down the two crowns to make cubes and calculate the volume that way, but that would mean ruining the crowns, not such a good idea. One day, as Archimedes was getting into the bath he noted the water spilling out as he entered. Archimedes theorized that the amount of water displaced out of the tub was directly related to the volume his body took up in the tub. He jumped out of the tub running naked in the streets yelling "Eureka! Eureka!" Greek for "I have found it!". By measuring the water displaced by each of the crowns he determine the volume of each; calculating the density he proved the goldsmith was using silver and gold not just pure gold because the gold alone was more dense than the silver gold combination(4).

As the lesson shows students how to calculate volume both geometrically and by water displacement method, you can discuss the possible causes of error between the two methods. In the geometric method we are actually squaring off the rounded edges of the Twinkie, therefore, we would expect the volume as calculated from geometric measurements to be slightly more than the volume obtained through the direct measurement water displacement method. At the end of the lesson the students can pool their results to calculate the class average for mass, volume and density, this will give them the opportunity to utilize mathematical averages which you may or may not have to guide them through.



Getting back to the Twinkie, volume can be determined the same way as Archimedes did it, submerge the Twinkie in a known amount of water and determine the volume of water displaced. When doing the water displacement test for volume, be sure to leave the Twinkie wrapped, remove the packaged air by making a small hole in the wrapping, gently pushing out excess air and resealing the package prior to submerging, this will give us the actual volume of the Twinkie. As you know the Twinkie is light and fluffy which is part of its appealing taste. So how much of the Twinkie is cake/cream and how much is air? Since we already know the volume of the Twinkie as made we will just need to measure the volume with the air removed. To do this we will liquefy the Twinkie in a blender and measure the volume of the Twinkie puree using a graduated cylinder (see photo to the left). It is then a simple calculation of:

$$\% \text{ Air} = \frac{\text{Initial Volume of the Twinkie} - \text{Volume of puree}}{\text{Initial Volume of the Twinkie}} \times 100\%$$

For reference, when I did the experiment I found the volume of the Twinkie through water displacement to be 140 milliliters compared to 143 milliliters utilizing the geometric mathematical method. The volume of the puree was found to be 42.8 ml, making the percentage of air in the Twinkie 69% (based on the 140 ml volume as determined by water displacement method). These values of course will vary slightly from group to group but the averages should be relatively close. For reference, I found the mass of the Twinkie was 44.5 grams with the density of the Twinkie calculated as 0.32 g/cm³. The object of the lesson is to have students learn the basic principles behind the measuring of density and determination of volume using two different methods.

Chemical Properties & Reactions

Chemical properties of matter are observed through chemical reactions; that is, the original substances, or reactants, combine or are separated chemically to form a new substance or substances called products. Take for example, the making of Monkey Bread at the end of lesson three, all of the ingredients are mixed together (exhibiting physical reactions/changes) and then the bread is baked which culminates in a new product which is, by definition, a chemical reaction. The overall concept to be remembered when deciding whether or not a change is a physical or chemical one is to determine if a new product has been made. Chemical change is a term that is synonymous with chemical reaction. In order to have a chemical change in a substance there must be a chemical reaction. This unit deals with chemical and physical properties and changes as they relate to baking treats.

Leavening Agents

What are leavening agents? Leavening agents are the components of a recipe that render the final product light and fluffy. There are three basic kinds of leavening agents, mechanical, chemical and biological. Leavening agents react with the moisture, heat and other ingredients in the recipe to produce a gas that becomes trapped in the batter or dough. It is this gas, upon heating, that gives rise to baked products.

Mechanical leavening involves the use of air or steam. Air is introduced to the batter or dough through beating, whisking or mixing, the air is then released during baking. Steam on the other hand is generated by the water in the batter that is converted to steam upon heating during the baking process. The trapped steam expands giving rise to the baked product.

Popovers and cream puffs are both good examples of mechanical leavening. Basically making popovers is a very simple recipe of flour, eggs, milk and a dash of salt, the air is incorporated mechanically while beating the ingredients together, the trapped air produced while mixing and the steam generated gives rise to the

popovers as they are baked in a hot oven. Another example of mechanical leavening is cream puffs. Cream puffs combine water, butter, flour and eggs, again the steam produced by the water and air incorporated during the mixing is released during the baking process.

The second type of leavening agent is chemical. Chemical agents give rise to the baked product when the chemical agent reacts to produce a gas (usually CO₂) which becomes trapped and then released during the baking process. The two chemical agents we will focus on are the most common ones, baking soda and baking powder. Any student who has ever made chocolate chip cookies or helped bake a cake has some previous knowledge of these "chemicals". Baking soda, sodium bicarbonate, is a mainstay in most homes, it is used as an abrasive cleaner, put in the fridge to absorb unpleasant food odors, flushed down the sink to clean and deodorize the pipes it can even end up in your toothpaste helping you keep your pearly whites-white. So what is exactly happening? The gas we are looking to produce is CO₂, carbon dioxide. Baking soda is sodium bicarbonate that reacts with a weak acid solid like cream of tartar according to the following equation:



Sodium Hydrogen ion + Sodium + water + carbon dioxide

Bicarbonate (from weak acid)

Most recipes today call for the use of baking powder which is just baking soda with the addition of a dry acid (cream of tartar) and starch. The acid in baking powder is inactive until it is mixed with water. The reaction of the sodium bicarbonate and the dry acid is relatively quick which is why a lot of recipes have you mix dry ingredients separate from the wet ingredients. Most baking powders are double acting leaveners, that is, the initial reaction noted above along with mechanical leavening gives rise to the batter at room temperature while the addition of sodium aluminum sulfate reacts only at an elevated temperature to cause the cake to rise while in the oven.

The third type of leavening agent is biological. Yeast is a unicellular fungi that can produce its own food releasing CO₂ and alcohol as waste products. The production of carbon dioxide is the result of the combination of yeast with sugar water. The chemical reaction that allows yeast to feed on simple sugars to produce energy needed for growth is called fermentation. The fermentation reaction is as follows:



Glucose Ethyl alcohol carbon dioxide energy needed to reproduce

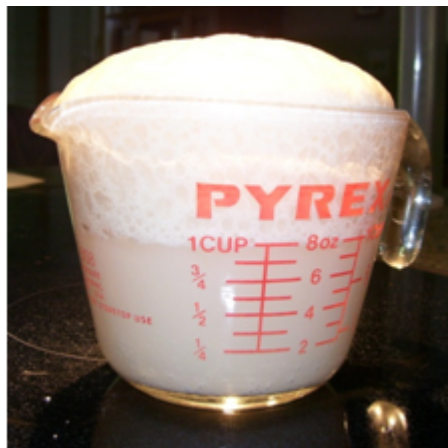
As seen in the reaction above, carbon dioxide and alcohol are the waste products produced by the fermentation process. These wastes are what bakers have taken advantage of for thousands of years to make light, fluffy leavened bread. The yeast and alcohol become trapped in the dough as bubbles. The dough batter is then mixed with flour where the starch in the flour forms a matrix supported by proteins. Upon baking the trapped gases evaporate leaving holes in the bread.

The last lesson in this unit allows students to see firsthand, the production of CO₂ utilizing active dry yeast and sugar water. Prior to doing the experiment you may want to do a demonstration using active dry yeast added to warm sugar water (1 tablespoon of table sugar to 1 cup of water heated to approximately 105°F) in a glass Pyrex measuring cup, as shown or in a glass beaker. The first photo below shows the initial reaction where the yeast is beginning to bud, approximately 2-3 minutes after mixture.



Yeast & Sugar Water Reaction at 2-3 minutes

The photo below is the same yeast/sugar water after the yeast has bloomed (reproduction) by fermentation (after fifteen minutes).



Yeast and sugar water reaction after 15 minutes

For reference, yeast production is temperature dependent, that is, at temperatures above the yeast will die, too cold and the reaction will not proceed. To emphasize this concept incorporate ice water and boiling water to the demonstration asking the students to predict what they think the outcome for each will be and have them explain why.

Lesson One Movin' Molecules

Objective

1. Students will be able to identify and define the three most common states of matter: gas, liquid, and gas.
2. Students will be able to visualize the three states of matter, gas, liquid and

solid by simulating molecules in motion.

Materials: Students, Classroom with desks set up in rows (at least two)

Procedure:

1. Initiate a discussion about what matter is and that matter is all around us, have students identify things made of matter.
2. Activate prior knowledge that all matter is made up of molecules tell students that today they are the molecules.
3. Instruct students to get out of their seats and move about the classroom, no space is off limits (except up on things)
4. As the students are moving about the classroom, sometimes bumping into one another ask "What state of matter are you molecules? A solid? A liquid or a gas?
After a few minutes guide students toward the rows of desks, place a chair on one end blocking the row off, move to the other end of the row and place another chair. The students
5. will still be able to move but now they are confined to the space between the rows. Ask the students to differentiate between the way they are able to move now compared to how they were able to move when they were a gas. Ask students "what state they are now in?"
6. Lastly, to simulate a solid push in the chair on one end of the row until the students are "packed" together, able to only "vibrate" Again ask the students "what state they are now?"

Lesson 2: Density of a Twinkie

Objective

- 1 .Students will be able to define the term density.
2. Students will determine volume of a Twinkie both geometrically and directly through water displacement method
3. Students will measure the mass and volume of a Twinkie to calculate density
4. Students will determine the percentage of air in a Twinkie (Teacher lead demo)

Materials:

Demo: 600 milliliter beaker; 400 milliliters water; black permanent marker;

Piece of Balsa wood; (2) Rocks

Student activities: Twinkies; balance; 1000 milliliter beaker; 50 ml graduated

cylinder; blender (teacher operated); Metric ruler; permanent marker; calculator

Procedure:

Demo: The teacher will introduce the lesson by asking students if anyone knows what we mean by density. After some discussion define density as mass (grams) per unit volume (milliliter or cubic centimeters). Explain that often chemists refer to density of an object compared to water. Show students the block of wood and the rock and ask which is more or less dense than water. Demonstrate that balsa wood is less dense than water because it floats and the rock is more dense because it sinks. Ask students how they might determine the density of a rock given a balance, beaker with water and a graduated cylinder; facilitate a discussion that leads to massing the rock with the balance and measuring the displaced volume of water, with the data collected, calculate the density.

Student activity I:

1. Have students get into groups of two or three.
2. Hand out the instruction and data sheets to each group (see end of lesson)
3. Review the basic instructions on calculating volume of the Twinkie by measuring the length, width and height of their Twinkie.
4. Give each group (1) Twinkie (have extras so everyone gets to have one after the lesson)
5. Have students calculate the volume of their Twinkie (length x width x height)
6. Have students measure the mass of the Twinkie using the balance
7. Students can then calculate density by dividing mass by volume.
8. Students can then eat their Twinkies

Student activity II: Determination of volume of a Twinkie using the direct, water displacement method. (see student worksheet at the end of the lesson)

Teacher lead activity to determine percentage of air in a typical Twinkie based on the volumetric difference between the calculated volume of a standard Twinkie compared to volume of the Twinkie after the removal of air.

1. Measure the length, width and height of a standard Twinkie; calculate the volume; record as V_1
2. Take a Twinkie and 5 milliliters of water place into a blender and puree (to remove air)
Carefully transfer the Twinkie puree into a 50 ml graduated cylinder , record the volume of
3. the Twinkie without air as V_{2a} . Final volume V_2 is equal to V_{2a} minus 5 milliliters of water added to help liquefy the Twinkie.
4. Have students determine the percentage of air in the Twinkie using the following formula:

$V_1 - V_2 / V_1 \times 100\% = \% \text{ air in a typical Twinkie}$

Student Instruction/Data Sheet:

Today we will be measuring both the mass and volume of a Twinkie, we will then calculate the density.

I. Determine the Mass of a Twinkie

Materials:

Twinkies

Triple beam balance

Procedure:

1. Unwrap the Twinkie
2. measure the mass of the Twinkie in grams using the triple beam balance and record the mass on your data sheet

II. Volume of a Twinkie: displaced water method

Materials:

1000ml beaker with 50 ml increments

500 mls water

Pin

tape

50 ml graduated cylinder

10 ml graduated cylinder

Permanent marker

Procedure:

1. Put 500 mls of water into the 1000 ml beaker

2. With a pin, poke a small hole in the top of the Twinkie wrapper and carefully push out the air.
3. Reseal the Twinkie package covering the pin hole with tape
4. Submerge the Twinkie into the water. While the Twinkie is submerged mark (with permanent marker) the new water level on the beaker
5. Remove the Twinkie
Using the 50 ml graduated cylinder add water back into the beaker up to the water level as
6. marked (you may need to utilize the 10 ml graduated cylinder for the last few milliliters needed to get to the mark)
7. Record the final volume on the data sheet as Volume (with Twinkie)

III. Volume of a Twinkie: Geometric calculation

Materials:

1. A Twinkie
2. Metric Ruler

Procedure:

1. Remove the Twinkie from the wrapper
2. Using a metric ruler measure the height, width and length of the Twinkie
3. Record each value in centimeters on the data sheet
4. Calculate the volume of the Twinkie using the following equation:
Volume = Length (cm) X Width (cm) X Height (cm)

IV. Density of a Twinkie

Density is defined as mass per unit volume. To find the density of the Twinkie

use the following formula:

Density = mass of the Twinkie (grams) / Volume of the Twinkie (cm³)

Student Data Sheet:

I Mass of the Twinkie _____ grams

II Volume of the Twinkie V_{wd} (Water Displacement Method)

Volume (with Twinkie) _____ mls

Volume (initial) _____ 500 mls

Volume of the Twinkie $V_{wd} = \text{Volume (with Twinkie)} - \text{Volume (initial)}$

III Volume of the Twinkie V_g (Geometric method):

Length of the Twinkie _____ cm

Width of the Twinkie _____ cm

Height of the Twinkie _____ cm

Volume (g) = length X width X height = _____ cm X _____ cm X _____ cm

Volume (g) = _____ cm^3

IV Calculation of the Density of the Twinkie:

$$\text{Density} = \frac{\text{mass (grams)}}{\text{volume (cm}^3\text{)}}$$

You may use either volume obtained in the experiment above, i.e. the volume calculated from the geometric measurements Volume (g) or the volume obtained directly from the water displacement method V_{wd} .

Lesson 3: Chemical and Physical Properties of Matter

Objective: Students will be able to identify and differentiate between physical and chemical properties and changes.

Procedure:

1. Initiate a discussion by accessing knowledge of previous lessons asking students to define matter and density. Introduce the day's topic Physical and Chemical Properties of Matter. Instruct students that all matter has certain properties some are physical and some are chemical. Physical properties are used to describe matter. Ask students "What do you think would be a physical property of a blackboard eraser?" Emphasize that physical properties describe matter

- Matter also has chemical properties. Chemical properties are observed through chemical reactions. Chemical reactions result in a new product being formed; something happens to change the chemical make-up of the reactant to produce a new product or products
2. Ask students if the following items listed represent a physical or chemical change and ask why or how they made the choice.
 - " Fireworks (chemical)
 - " Melting butter (physical, it is still butter just in a different state)
 - " Carving a design in a wooden block (physical, still wood)
 - " White coating on aluminum lawn furniture (chemical the outside of the aluminum reacted with the air to form a coating)
 - " Rusty nail (chemical, the iron in the nail reacted with the air to form rust)
 - " Evaporation (physical, still water just is in the form of a vapor)
 - " Getting a hair cut (physical, still hair)...coloring your hair (chemicals are used to alter the color of your hair)
 - " Foliage (chemical)
 4. Reaction in the kitchen, let's look at what we do when we make monkey bread, which steps are physical changes and which are chemical?
 - " First, melt $\frac{3}{4}$ cup butter
 - " Next, mix 1 tsp. cinnamon with $\frac{1}{2}$ cup white granulated sugar place in a large food storage bag
 - " Cut up two packages of refrigerated cinnamon rolls (not cooked)
 - " Toss the cut up roll pieces in the bag with cinnamon & sugar mixture
 - " Once coated place pieces into a buttered bunt pan
 - " Add 1 cup of brown sugar to the melted butter
 - " Pour the melted butter & sugar mixture over the top of the coated roll pieces
 - " Bake at 350 degrees Fahrenheit for 30 minutes
- Closure: Break out the Monkey bread and eat it up! Physically pulling it apart then eating, which by the way is a chemical reaction as the enzymes in your saliva breaks down bread and begins the process of digestion. Save that for another lesson.
- 5.



Monkey Bread

Lesson 4: Yeast Air Balloons: Production of CO₂

Objective: Students will observe the production of CO₂ gas as yeast feeds on sugar in water to produce ethanol (an alcohol) and carbon dioxide.

Initiation: Using a fresh loaf of yeast leavened bread ask students how they think the baker can possibly make the bread so light and fluffy. Facilitate the discussion towards the use of yeast. The use of yeast dates back to the Egyptians when bread and beer and wine were main sources of nutrition. As yeast feast on sugar a chemical reaction occurs that produces both carbon dioxide gas and ethyl alcohol as waste products as well as energy needed for cell reproduction. The students will see the production of CO₂ as evident by the inflation of the balloon. The chemical reaction is as follows:

Yeast + C₆H₁₂O₆ → 2C₂H₅CH₂OH + 2 CO₂ + energy

Glucose Ethyl alcohol carbon dioxide energy needed to reproduce

Materials: 1 packet of dry yeast (baker's yeast); 1 cup of water; 250 milliliter beaker; thermometer; hot plate; 2 tablespoons of sugar; large rubber balloon; empty water bottle

Procedure:

1. Have students get into groups of two or three
2. Have each group gather materials listed
3. Place the cup of water into the beaker on the hot plate and heat to 110° F
4. Stretch the large balloon then blow it up and let the air out, repeat a couple of times
5. Once the water is heated, add the two teaspoons of sugar mix thoroughly (so all the sugar is dissolved)
6. Next, add the dry yeast to the sugar water and stir to mix. Transfer the yeast/sugar water mixture quickly to the water bottle and attach the balloon on top of the bottle.
7. The generation of CO₂ will begin within 10 minutes, have students record their observations in their lab notebooks

Closure: Ask students "Why do you think there are holes in a loaf of fresh bread in which the bakers has used yeast in the dough?"

Notes

(1) Density of common substances which is on line at
<http://hyperphysics.phy-astr.gsu.edu/Hbase/Tables/density.html> 7/6/09

- (2) Density of gold and silver, CRC Handbook of Chemistry and Physics, 61st Edition, 1980 page B-245
(3) Lesson adapted from The T.W.I.N.K.I.E.S. Projects which is on line at <http://twinkiesproject.com>
(4) Visionlearning: Density http://www.visionlearning.com/library/module_viewer.php?mid=37

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Appendix I-Content Standard

This unit correlates with New Haven Public School Seventh Grade Science Curriculum: Unit I. Properties of Matter and Unit 2. Chemical Properties as well as the following Connecticut State Standard:

Properties of Matter - How does the structure of matter affect the properties and uses of materials?(PHYS)

6.1 - Materials can be classified as pure substances or mixtures, depending on their

chemical and physical properties.

Mixtures are made of combinations of elements and/or compounds, and they can be separated by using a variety of physical means.

Pure substances can be either elements or compounds, and they cannot be broken down by physical means.

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