



PHYSICAL AND CHEMICAL CHANGES IN FOOD

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Annotation:

This hands-on activity rotates students through ten stations, each illustrating a physical or chemical change commonly occurring in food. Students are asked to classify each example as a physical or chemical change and answer questions specific to each.

Primary Learning Outcomes:

Students will be able to define the following terms: *physical properties*, *chemical properties*, *physical change*, and *chemical change*.

Students will be able to distinguish between physical and chemical changes.

Students will be able to recognize the four indicators that a chemical change has occurred.

Students will be able to classify changes associated food as physical or chemical.

Additional Topics Covered:

- Characterization of matter
- Kinetic theory of matter
- Freezing point depression/boiling point elevation
- Solubility

Assessed QCC:

Grade: 9-12

Science

Physical Science

5 Topic: Matter: Structure and Properties

Standard: Quantifies mass, weight, volume, density, conductivity, and temperature as physical properties of objects in the learner's environment.

5.1 Distinguishes physical from chemical properties.

6 Topic: Matter: Structure and Properties

Standard: Identifies chemical or physical changes conceptually in a laboratory setting.

6.1 Differentiates chemical from physical changes in the following laboratory investigations: combustion, fermentation, melting, dissolving, metabolism, boiling, and electrolysis.

Duration:

Teacher Preparation: 30 minutes

Introduction: 5 minutes



Student Activities: 70 minutes

Conclusion: 15 minutes

Total Class Time : 90 minutes

Materials and Equipment:

For Teacher Preparation:

1. Drinking water
2. Sugar-free Kool-Aid mix
3. Apple
4. Apple slicer
5. Bowl
6. Bread dough mix
7. Mixing bowl
8. Mixing spoon

Per class:

Station 1:

1. Toaster
2. Loaf of bread

Station 2:

1. Hershey Kisses

Station 3:

1. Bottle of Coke
2. Bottle of flat Coke
3. 4 oz. paper cups
4. pH paper

Station 4:

1. Alka-Seltzer tablets
2. Beaker
3. Water
4. pH paper

Station 5:

1. Bowl of dry cookie mix
2. Cookies

Station 6:

1. Kool-Aid drink
2. Rock salt
3. Gallon-size freezer bags
4. Quart-size freezer bags
5. Measuring cup
6. Ice
7. Spoons

Station 7:

1. Apple slices
2. Apple slices submerged in water

Station 8:

1. Bread dough
2. Slices of bread

Station 9:

1. 2 bottles Ken's Steak House

Station 10:

1. Sugar-free Kool-aid mix



Caesar salad dressing

2. Pitcher of water
3. 4-oz. paper cups
4. 1 qt. plastic water bottle

Safety:

Students should use caution when using the toaster.

Technology Connection:

Not applicable.

Procedures:

Teacher Preparation:

Set up the ten stations so that each contains the station procedures and materials listed.

The following stations require additional set up.

Station 3:

Remove the caps from half of the bottles of Coke and allow them to flatten. Allow them to sit overnight if possible.

Station 5:

Place the dry cookie mix in a bowl for easier viewing.

Station 6:

Prepare Kool-Aid drink by adding two Kool-Aid packets to one gallon of drinking water. Students will sample the Kool-Aid, so prepare as many gallons as you see necessary.

Station 7:

Using the apple slicer, slice an apple. Place several of the slices in bowl and cover with water. Allow the other slices to sit out on the counter and brown. Allow the slices to sit out overnight if possible.

Station 8:

Prepare the bread dough in the mixing bowl as directed on the box. Place the bowl of dough at the station.

Station 10:

Fill the pitcher with water and place at the station. Divide five packets of Kool-Aid mix in half. Place each half in a small plastic zipper bag.

Estimated Time:

60 minutes



Introduction:

Discuss with students the following terms:

1. Physical property – any property of matter that can be measured without changing its chemical nature
ex. Mass, volume, density, color, texture, melting point, boiling point
2. Chemical property – a property of matter that can be observed only when substances interact with one another
ex. Combustability, solubility, flammability
3. Physical change – a change that affects only physical properties
ex. change of state
4. Chemical change – a change that produces one or more new substances

Evidence that a chemical reaction has occurred:

1. the evolution of a gas (bubbles, odor)
2. the formation of a precipitate (insoluble solid formed from a solution)
3. the emission or absorption of energy (heat or light)
4. a color change in the reaction system

*If both physical and chemical changes occur, the chemical change is of primary interest in this activity.

Review with students the lab procedures set forth in the student handout, and inform students of the procedures for rotating through each of the ten student stations.

Estimated Time:

5 minutes

Student Stations:

Students should follow procedures found at each station. (*Procedures for each station are attached and should be posted at each station.*)

Estimated Time:

70 minutes

Conclusion:

Review each station with the students, discussing the correct classification of each physical and chemical change, along with key indicators that led to the classification. An explanation of each station follows.

Station 1:

Toasting is a chemical change caused by Maillard, or nonenzymatic, browning. During the Maillard reaction, the aldehyde group of a sugar molecule reacts with the amine group of an amino acid or protein molecule, leading to the formation of brown polymers and highly flavored chemicals. In addition



to bread, the Maillard reaction is responsible for the color and flavor of many carbohydrate- and protein-rich foods, including onions and grilled and roasted meats.

Station 2:

A unique quality of chocolate is that it melts at body temperature. The heat added to the kiss when placed in the mouth causes the kiss to change from a solid to a liquid. Therefore, the melting of a kiss is a physical change.

Station 3:

The process by which a soda goes flat is a physical change. When a soda can is opened, there is a rapid escape of gas from the liquid, called effervescence. The escaping material, in the form of bubbles, is carbon dioxide. The escape is due to a decrease in pressure within the can, causing the solubility of the carbon dioxide to decrease and come out of solution. (Ways in which to add carbon dioxide to a solution: using a living organism called yeast, using chemicals that release gas when mixed with certain kinds of liquids, or bubbling the gas through the solution and allowing it to dissolve).

Station 4:

The change that occurs when an Alka-Seltzer tablet is added to water is chemical. A chemical reaction occurs when the sodium bicarbonate of the tablet mixes with water. The reaction releases carbon dioxide which can be seen as bubbles in the water. The tablets are an antacid. An antacid is a strong base that helps to neutralize or decrease the acid levels in the stomach. This change in the acid level helps to relieve indigestion and heartburn.

Station 5:

The baking of cookies is a chemical reaction. Heat is added to the cookie dough, thus catalyzing a cascade of chemical reactions. Students may be most familiar with the reaction involving baking soda, a leavening agent responsible for the rise (shape) in the cookies.

Station 6:

The freezing of the Kool-Aid solution is a physical change. Salt, when added to the water, lowers the freezing point of the water, resulting in an ice water solution that is colder than the normal freezing point of water (0°C). This ice water solution is then able to absorb enough energy from the Kool-Aid solution to cause it to begin to freeze.

Station 7:

When you cut the apple, you open up some of its cells. Cells contain thousands of enzymes that are necessary for the cell to live its life. The browning of apples involves an enzyme called polyphenol oxidase. When cut, the enzyme has access to oxygen in the air and undergoes a chemical reaction that causes the fruit to turn brown. The easiest way to prevent browning is to put the sliced apples in water so that the enzyme does not have access to oxygen. You can also heat the apples to denature the enzyme.



Station 8:

The rising of dough is a chemical change. Yeast, a single-cell fungi, metabolizes sugar to create alcohol and carbon dioxide. The carbon dioxide gas created gives bread its airy texture. Gluten, a stretchy balloon-like protein found in flour, captures the carbon dioxide produced by yeast in tiny flour balloons, causing the dough to rise. The alcohol, which burns off during baking, leaves behind an important component of the bread's flavor.

Station 9:

The mixing of salad dressing is a physical change. The dressing is made up of several immiscible layers of ingredients, and shaking of the bottle causes a temporary emulsion and suspension.

Station 10:

The dissolving of the Kool-Aid powder into water is a physical change. The powder, the solute, is dissolved in water, the solvent, forming a Kool-Aid solution.

Estimated Time:

15 minutes

Assessment:

Students should be assessed based on completion of the student handout.



Procedures for *Station 1*

- **Place a slice of bread in the toaster and toast.**
- **As the first slice of bread toasts, examine a second slice of bread. Record on your student handout all observations of appearance, texture, and aroma.**
- **When toasting is complete, remove the toast from the toaster and allow it to cool.**
- **Examine the toast. Record on your student handout all observations of appearance, texture, and aroma. Indicate any changes that occurred as a result of toasting.**
- **Properly dispose of bread and toast.**



Procedures for *Station 2*

- **Unwrap a Hershey Kiss and record on your student handout its state on your student handout.**
- **Place the Kiss in your mouth and allow it to sit on your tongue. Do not chew the Kiss.**
- **Record on your student handout all changes that occur within your mouth, including any change of state.**
- **Properly dispose of all wrappers.**



Procedures for *Station 3*

- **Pour yourself a sample of both the Coke and the flat Coke.**
- **Record on your student handout any differences in appearance between the two samples.**
- **Sample the Coke and the flat Coke, making sure not to drink all of your samples. Record on your student handout any differences between the two samples.**
- **Using the pH paper, measure the pH of both samples and record on your student handout.**
- **Properly dispose of the samples.**



Procedures for *Station 4*

- **Unwrap and examine an Alka-Seltzer tablet.**
- **Record on your student handout all observations of appearance and state.**
- **Fill a beaker with water. Using the pH paper, measure and record on your student handout the pH of the water.**
- **Place the tablet in the beaker of water.**
- **Record on your student handout all observations of the tablet and the water.**
- **Using the pH paper, measure and record on your student handout the pH of the water and tablet solution.**
- **Pour the contents of the beaker down the drain.**
- **Rinse and dry the beaker.**



Procedures for *Station 5*

- **Examine the cookie dough mixture. Record on your student handout all observations of appearance, texture, and aroma.**
- **Examine a cookie. Record on your student handout all observations of appearance, texture, and aroma.**
- **Indicate any changes that occurred as a result of baking.**
- **Enjoy your cookie.**
- **Dispose of any garbage.**



Procedures for *Station 6*

- **Fill a small plastic zipper bag with a half cup of Kool-Aid and tightly seal.**
- **Record on your student handout all observations of appearance and state of the Kool-Aid solution.**
- **Place the small bag, along with those of your groupmates, in a large plastic zipper bag.**
- **To the large bag, add 1 cup of rock salt and 3 cups ice. Tightly seal the bag.**
- **Gently shake the bag for several minutes until a change of state is observed in the Kool-Aid.**
- **Remove small bags from the large bag and record on your student handout all observations of appearance and state of the Kool-Aid solution.**
- **Use the provided spoon to enjoy your Kool-Aid.**
- **Dispose of all garbage.**

Procedures for *Station 7*

- **Examine the apple slices lying on the counter, and record on your student handout all observations of appearance, texture and aroma.**
- **Examine the apple slices submerged in water, and record on your student handout all observations of appearance, texture and aroma.**
- **Note any differences between the apples.**

Procedures for *Station 8*

- **Examine the bread dough. Record on your student handout all observations of appearance, texture, and aroma.**
- **Examine the slices of baked bread. Record on your student handout all observations of appearance, texture, and aroma.**
- **Indicate any changes that occurred as a result of baking.**



Procedures for *Station 9*

- **Observe the bottle of salad dressing labeled “DO NOT SHAKE” and record on your student handout observations of its appearance, consistency, and type of mixture.**
- **Carefully shake the bottle of salad dressing labeled “SHAKE.” Record on your student handout all changes observed as a result of shaking.**



Procedures for *Station 10*

- **Fill the plastic bottle to the 32 ounce mark with water.**
- **Examine the Kool-Aid mix and record on your student handout observations of appearance, texture, and state.**
- **Add the contents of one pre-measured bag of Kool-Aid mix to the water bottle.**
- **Place the lid on the bottle and tighten. Slowly invert the bottle several times.**
- **Examine the resulting solution and record on your student handout all observations of appearance, texture, and state.**
- **Use the provided cups to enjoy your Kool-Aid.**
- **Dispose of any garbage and pour any remaining Kool-Aid down the drain.**
- **Rinse and dry the plastic bottle.**



Name:

Date:

Class Period:

PHYSICAL AND CHEMICAL CHANGES IN FOOD

Student Handout

Introduction:

The food that we eat undergoes a number of changes, both chemical and physical. For example, foods are fermented, frozen, cooked, and cured. These changes are a vital part of the processing food undergoes before making its way to our plate.

Purpose:

To classify changes occurring in foods as chemical or physical.

Procedure:

This laboratory exercise comprises 10 stations. Throughout the period, you are to visit each of the 10 stations. Procedures are listed at each station. You will have 7 minutes to complete each of the tasks, so work efficiently. Your teacher will notify you when it is time to move on to the next station. Remain at your station, with your groupmates, at ALL times. Points may be deducted from your assignment if you fail to do so.

At each station, perform the tasks listed. Found on the back of this handout is a data table to be completed for each task. In the appropriate section of the table, list the task, all observations, the type of change (chemical or physical), and supporting evidence of the type of change. For full credit, all information in the table must be accurate and complete. Upon completion of all ten stations, answer the discussion questions found below.

Discussion Questions:

1. What do you think causes the toast to brown?
2. What is the approximate melting point of chocolate? How do you know this?
3. What gas fills the bubbles released from a newly opened Coke? Where does it come from?
4. What gas fills the bubbles that are released from the Alka-Seltzer tablet?
5. Is it possible, when baking, to observe both chemical and physical changes? Provide an example.
6. Road workers add salt to roads in the winter to keep them from icing. Using this as an example, explain why salt was added to the ice when freezing the Kool-Aid drink.
7. How did submersion in water prevent the apples from browning?
8. What ingredient is most important in the rising of dough?
9. Why do some salad dressings not separate while others do?



10. Will any amount of Kool-Aid mix dissolve in the given volume of water?

| Station | Task | Observations | Type of Change | Supporting Evidence |
|---------|------|--------------|----------------|---------------------|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
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