



Chemistry in the Garden

5th Grade

Standards

GPS S-5P1

NGSS 5-PS1-4

Time

3 or 4 45 minute sessions

Supplies

Plants to harvest from school garden

- Red cabbage leaves
- Coffee filters
- Microwave or
- Lettuces and salad greens
- Tomato, pepper, onion, cilantro
- Fruits
- Pancake mix
- Mint
- Apples
- Potatoes
- Iodine
- Mint

Food preparation supplies

- Bowls
- Knives, cutting boards (optional)
- 3 jars
- Sun tea jar
- Tea bags
- Cook stove

Garden Connection

Students will grow plants in the garden and conduct investigations into chemical and physical changes.

STEM Connection

QR codes and tablets or smartphones will be used to create trail guides.

Overview

Students will explore chemical reactions and physical changes when fruits and vegetables are harvested from the garden and prepared to eat.

Essential Question

How do we know when a chemical reaction has taken place? Or do we know when a substance undergoes a physical change? What is the difference?

Engaging Students

Students will explore garden chemistry by conducting investigations into use of red cabbage as a pH indicator, and iodine as an indicator of starch (present in fruits and vegetables before they ripen and starch is converted to sugars).

Exploration

Students will prepare foods from the garden and conduct investigations to observe whether physical changes or chemical reactions take place.

Explanation

Students will argue about whether a chemical reaction or physical change has taken place, citing evidence such as indicators observed, and other factors.

Environmental Stewardship

Students will create a Guided Chemistry Trail through the gardens or schoolyard, using QR code technology or audio recordings to explain the chemistry of various plants, soils and elements in the garden.

Evaluation

A rubric is provided to assess student performance and understanding of indicators that a chemical reaction has taken place.

Extension

Students may also make the recipes they created, as an extension activity.

Standards

Georgia Performance Standards in Science

S5P1. Obtain, evaluate, and communicate information to explain the differences between a physical change and a chemical change.

- Plan and carry out investigations by manipulating, separating and mixing dry and liquid materials and communicate collected data to demonstrate examples of physical change.
- Construct an argument based on observations that the physical changes in the state of water are due to temperature differences, which cause small particles that cannot be seen to move differently.
- Plan and carry out an investigation to determine if a chemical change occurred based on observable evidence (color, gas, temperature change, odor, new substance produced)

Next Generation Science Standards

5-PS1-4 Matter and Its Interactions

Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Teacher Background Information

Chemical reactions happen when bonds between atoms are made or broken, irreversibly changing a substance's chemical composition. Physical changes are changes in form that do not affect a substance's composition. Cooking can be confusing, in terms of the physical vs chemical changes that take place. This resource from the European Food Information Council explains [The Why, How and Consequences of Cooking Our Food](#). For background on the chemical reaction that happens when iodine encounters starch in a vegetable, check out Explorit's [Starchy Potato Chemistry](#) web pages. An explanation of the chemical reaction that takes place when a pH indicator is used, is included in [this Wikipedia article](#). For good background information on the chemical reaction and color change that occurs when red cabbage juice – a pH indicator – encounters an acid or base, see the [Science Buddies Cabbage Chemistry](#) lesson.

Teacher Preparation

Assemble materials and equipment necessary for students to harvest and prepare food from the garden, including bowls, knives and cutting boards (if allowed), washing facilities, cooktop or griddle, spatula, paper cups for student taste-testing. Time the lesson to coincide with garden harvest, if possible, to minimize the number of foods that have to be obtained commercially. Substitute fruits, vegetables and other recipe ingredients, as necessary.

PROCEDURES FOR LESSON ACTIVITIES

Day 1

Engagement (45 minutes)

Students will explore garden chemistry by conducting investigations into use of red cabbage grown in the garden as a pH indicator, and iodine as an indicator of starch (present in fruits and vegetables before they ripen and starch is converted to sugars). The iodine test is described here, in [Starchy Potato Chemistry](#). Iodine dripped on sliced potatoes and fruits will show how ripe they are, as starch turns brown / black in the presence of iodine. On more ripe (sugary) fruits – or sections of fruit – the iodine stays purple. When an indicator changes color, a chemical reaction takes place.

This [Cabbage Chemistry](#) activity from Science Buddies or Steve Spanglers' [Red Cabbage Chemistry](#) can be used as a starting point for students to design investigations. To do a demonstration before students replicate the lab: A microwave can be used to cook several red cabbage leaves in water. The resulting purple liquid can then be divided into three clear cups. Pour vinegar into one cup and stir to see that the purple indicator solution turns red in the presence of an acid. Acids range from 0 to 6.9 and are lower in pH than neutral purple, at 7. In the third cup, pour in a teaspoon of washing soda or powdered laundry detergent and watch the liquid turn green in the presence of a base (from 7.1 – 14). Dip coffee filter paper strips into the purple cup and let them dry for an hour, to create indicator strips. Then make a prediction, dip a strip in a substance, and watch to see if the strip turns red (indicating an acid), stays purple (indicating neutral) or turns green (indicating a base).

Students should learn that, in addition to color change, other evidence of chemical reactions are production of a gas, change in temperature without heat being added or taken away, new odor, burning, or formation of a precipitate

when two liquids are combined. But not all mixtures of ingredients result in chemical reactions. Explain that components that are changed in size or shape and then combined are examples of physical change. Phase change is another type of physical change (as when water boils, condenses or freezes).

Day 2

Exploration (45 minutes)

Students will investigate physical and chemical changes in food that is harvested from the garden and prepared to eat in various ways. Refer to Garden Chemistry Lab Report 1 for possible investigations, depending on what is available from the garden. Be sure to include, at a minimum:

- A mixture of raw foods such as a salad, where the size and shape of ingredients change but not the substance
- A mixture of raw foods that are beaten or changed in form (but not substance) such as a smoothie
- A bread, pancake or cake recipe that results in bubbles rising in batter as it cooks (evidence of chemical change)
- A food in which the color changes due to oxidation or an indicator solution or other chemical reaction
- A food that is browned or burned by flame, resulting in a chemical reaction.

Day 3

Explanation (45 min – 1 hour)

Students will argue about whether a physical and chemical change takes place when particular items are combined, using the five major indicators of chemical change as evidence for their arguments. Examples may be drawn from Chemistry Lab Report #1. Students may further demonstrate their understanding of this core idea by creating a recipe that results in physical changes and another recipe that results in chemical reactions. See Lab Report #2.

Day 4

Environmental Stewardship (2- 45 minute sessions)

Teams of students will create guided chemistry trails through the gardens and schoolyard, placing numbered markers at places of interest and using QR code technology, audio recordings, or a printed trail guide to explain the chemistry (or physical changes) of various plants, soils and elements in the garden. For reference and inspiration, check out this [Oxford Botanic Garden Chemistry Audio Tour](#). Garden Chemistry Lab Report #3 can be used to outline this activity.

Evaluation

An assessment rubric is provided to measure student performance related to the standard and understanding of the core idea.

Extension

Students may want to make and taste-test the recipes they created, as an extension activity.



Garden Chemistry Lab Report 1

Name(s): _____

Check appropriate box to indicate how you prepared food from the garden and what you observed:

| What do you observe → What did you do? V | Chemical Reactions | | | | | | Physical Changes | | |
|--|------------------------|---------------|-------------|------------------------------|--|--|---------------------------|----------------------|---|
| | Burns? (ash formed) | Color Change? | Odor forms? | Gas Forms? (bubbles seen) | Temperature changes? (without substance being heated or cooled) | Precipitate forms? (solid falls out of two liquids) | Changes in size or shape? | Dissolves in liquid? | Changes phase? (from solid to liquid or liquid to gas or v.v.) |
| Lettuces torn and radishes cut to make a salad | | | | | | | | | |
| Pancake mix combined with milk and blueberries and cooked on stove | | | | | | | | | |
| Iodine dropped on cut potato to detect starch | | | | | | | | | |
| Ice, blueberries, strawberries, and bananas blended into smoothie | | | | | | | | | |
| Chocolate melted and then re-hardened on sticks | | | | | | | | | |
| Marshmallow toasted over a fire | | | | | | | | | |
| Cabbage juice used to detect acidic and basic substances | | | | | | | | | |
| Tomatoes, peppers, onions, and cilantro cut up to make salsa | | | | | | | | | |
| Sugar stirred into warm sun tea made with mint sprigs | | | | | | | | | |
| Apple slices turn brown when sitting out in the air | | | | | | | | | |

[Changes cannot be undone because new substance has been formed]

[Changes don't make a new substance]



Garden Chemistry Lab Report 2

Name(s): _____



Name and create a recipe featuring food from the garden that is changed physically. Give evidence that showed this recipe included a physical or phase change.

Name and create a recipe featuring food from the garden that undergoes a chemical reaction when it is prepared to eat. Tell how you know it is a chemical reaction, citing indicators evidence.





Garden Chemistry Lab Report 3

Name(s): _____

Guided Chemistry Trail

Marker #1: Plant or Feature of Interest / Location _____

Info: _____

Marker #2: Plant or Feature of Interest / Location _____

Info: _____

Marker #3: Plant or Feature of Interest / Location _____

Info: _____

Marker #4: Plant or Feature of Interest / Location _____

Info: _____

Marker #5: Plant or Feature of Interest / Location _____

Info: _____



Assessment for Chemistry in the Garden

Student Name(s): _____

Date: _____

| <p style="text-align: center;">Level of Mastery</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">→</p> <p style="text-align: center;">Benchmark or Performance Measure</p> |  <p style="text-align: center;">EMERGING Not yet proficient 1 point</p> |  <p style="text-align: center;">COMPETENT Partially proficient 4 points</p> |  <p style="text-align: center;">PROFICIENT Mastered task 5 points</p> | <p style="text-align: center;">TOTAL POINTS</p> |
|---|--|--|--|--|
| <p>Investigating indicator solutions such as red cabbages and iodine</p> | <p>Student cannot detect pH using cabbage indicator solution nor detect starch using iodine.</p> | <p>Student can detect either pH using cabbage indicator solution or detect starch using iodine.</p> | <p>Student can detect pH using cabbage indicator solution and detect starch using iodine.</p> | |
| <p>Distinguishing between physical and chemical changes</p> | <p>Student was unable to correctly identify at least 8 physical or chemical reactions in food preparation</p> | <p>Student correctly identifies 8 of 10 food preparation techniques, in terms of whether they feature physical changes or chemical reactions</p> | <p>Student correctly identifies whether 10 food preparation techniques feature physical changes or chemical reactions.</p> | |
| <p>Concocting Recipes</p> | <p>Students created recipes that did not correctly identify a physical change in one and a chemical reaction in another.</p> | <p>Student created a recipe that either correctly identified a physical change; or correctly featured a chemical change.</p> | <p>Student created a recipe that correctly identified a physical change; and another recipe that correctly identified a chemical change.</p> | |
| <p>Creating Guided Chemistry Trails</p> | <p>Student participated on a team that created a Guided Chemistry Trail through the schoolyard or garden, identifying 3 or fewer points of interest related to chemicals, reactions or physical changes.</p> | <p>Student participated on a team that created a Guided Chemistry Trail through the schoolyard or garden, identifying at least 4 points of interest related to chemicals, reactions or physical changes.</p> | <p>Student participated on a team that created a Guided Chemistry Trail through the schoolyard or garden, identifying at least 5 points of interest related to chemicals, reactions or physical changes.</p> | |