

# SOILS

## The Lifeblood of Plants

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# Tennessee 4-H Youth Development

## ***Soils***

### *The Lifeblood of Plants*

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#### **Skill Level**

Intermediate/Advanced

#### **Learner Outcomes**

*The learner will be able to:*

- Describe what an indicator does.
- Understand the pH scale.
- Differentiate between acids and bases.

#### **Educational Standard(s) Supported**

CHEM1.PS1, CHEM2.PS1, PSCI.PS1

#### **Success Indicator**

*Learners will be successful if they:*

- Identify the pH of at least four household items.

#### **Time Needed**

45 minutes to one hour (depends on boiling)

#### **Materials List**

- Red cabbage
- Strainer
- Pot of water, boiling
- Clear, plastic drinking glasses/cups
- Measuring spoons
- Household test chemicals: baking soda, hydrogen peroxide, laundry detergent, ammonia, lemon juice, lemon-lime soda, vinegar and water
- *Soil pH Experiment Guide PowerPoint*
- *Soil pH Experiment Data Sheet*

#### **Introduction to Content**

Soil performs many critical functions in almost any ecosystem such as lawns, farms, forests, grasslands, marshes or suburban watersheds. It is the topmost layer of the earth and is essential for life on earth. Having the right soil pH is key to growing healthy plants.

The pH scale has 14 units and is centered on seven, which is neutral. Levels below seven are considered in the acidic range and readings above seven are in the alkaline (or basic) range. Substances with low pH are very acidic, while those with high pH are highly basic.

#### **Introduction to Methodology**

This activity guides students through understanding the role soil pH plays in how available nutrients in the soil are for plants. Students will conduct an experiment using household items to measure pH and then apply that knowledge to select appropriate plants for a given soil pH.

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## Terms and Concepts Introduction

indicator – any substance that gives a visual sign, typically by yielding a color change in the presence or absence of a solution.

pH (potential of hydrogen) – a scale used to classify acidity or basicity (alkalinity) of a water-based solution.

soil – upper layer of earth in which plants grow consisting of a mixture of organic matter, clay and rock particles.

## Setting the Stage and Opening Questions

Show the first 1:22 of the YouTube video: [A Colorful Magic Trick with Acids and Bases](#).

Lead a discussion with students about pH using the following talking points:

- Scientists measure the acidity or alkalinity of a solution using a logarithmic scale called the **pH** or potential of hydrogen scale.
- The pH scale is used to classify acidity or basicity (alkalinity) of a water-based solution.
- The pH scale has 14 units and is centered on seven, which is neutral. pH levels below seven are considered in the acidic range (0-6) and readings above seven are in the alkaline (or basic) range (8-14).
- Substances with low pH are very acidic, while those with high pH are highly basic.

Share the following information about soils with students:

We all know that **soil** anchors plant roots and serves as a warehouse for essential nutrients for plant growth. Soils are complex mixtures of minerals, water, air, and organic matter. Every plant requires different soil conditions, yet we take these differences for granted. Plants grow best in their proper soil pH.

In this activity, we will explore an important phenomenon that occurs in molecular interactions within soil. Some substances are classified as either an acid or a base. Scientists can tell if a substance is an acid or a base by means of an indicator. An **indicator** is typically a chemical that changes color if it comes in contact with an acid or a base.

Tell students: **Let's conduct an experiment to learn more about acids and bases. You will generate a hypothesis about which household chemicals serve as an indicator and what their pH is.**

## Experience

Divide students into groups of 2-3. Use the *Soil pH Experiment Guide* to guide students through completing the experiment described below. Encourage students to complete the Soil pH Data Sheet. Use all or some of the listed household test chemicals.

1. Cut up red cabbage leaves so you can place 2–3 cups into a saucepan and cover with water.
2. Bring the water to boil for 5 minutes and then turn off the heat and let cool for 30 minutes.
3. Pour the purplish cabbage liquid through a strainer into a jar to filter out the chunks of cabbage.
4. Set out several clear drinking glasses and fill each glass with 2–3 Tablespoons (Tbsp) of cabbage juice.
5. Add 1 teaspoon (tsp) water to the first glass of cabbage juice and stir with a spoon.
6. Using the indicator guide below, record the estimated pH and a description of the solution in the data table.
7. Starting with ½ tsp, add vinegar to the second glass of cabbage juice until you see the solution change in color. Add in ½ tsp increments so you can record how much vinegar was added. Stir with a spoon after you add each ½ tsp. Note the color change and record the estimated pH and a description of the solution in the data table.
8. In the third glass, add 1 tsp laundry detergent and stir the solution with a spoon. Note the color change and record the estimated pH and a description of the solution in the data table.
9. Add the other test substance from the supplies list each to a new glass with cabbage juice. Note the color change and record the estimated pH and a description of the solution in the data table.

<b>Color:</b>	Pink	Dark Red	Violet	Blue	Blue-Green	Green-Yellow
<b>Approximate pH</b>	1-2	3-4	5-7	8	9-10	11-12
<b>Acid/Basic</b>	Acid	Acid	Acid/Neutral	Basic	Basic	Basic

## Tips for Engagement

See if anyone has had to test the pH of the pool or seen it tested while at the local recreation center or YMCA.

As a group, view the following YouTube video from The University of Tennessee Institute of Agriculture on soil testing done in Nashville.



## Share

Lead a discussion about the experiment results with students:

- Review the classification as an acid, neutral or base for each item.
- For which household items was your hypothesis most correct?
- Which results surprised you the most? Why?
- Share some other typical household items and ask students to share whether they think the item is an acid, neutral or base.

## Process

Explain to students how the experiment works:

- Everything is made of chemicals. Chemicals can be sorted into various categories, such as acids, bases and neutrals.
- Red cabbage juice is called an indicator because it shows us something about the chemical composition of other substances. Cabbage juice is naturally neutral (pH 7.0). When it is neutral, it is a purplish color.
- If an acid (0-6.0) is poured into it, it will turn a reddish color. If a base (8.0-14.0) is added, it turns blue or greenish.
- Vinegar made your solution turn red, so vinegar is categorized as an acid.
- Baking soda made your solution turn blue or greenish, so baking soda is a base.

Ask students: **So given what you've learned today, how do you think the guy in the magic trick video was able to make the water from the kettle change colors as he poured it?**

## Generalize

Discuss the following with students:

Did you know that soil pH plays a major role in how well your plants can absorb the nutrients you provide them?

Proper soil pH promotes root development, reduces the incidence of certain physiological disorders, like blossom end rot, and reduces incidences of certain diseases.

If you plan on growing vegetables in your garden or have a lush and healthy lawn, soil pH is an important factor to know. Soil pH is a measure of the acidity or alkalinity level of the water in your soil. Most plants thrive in the 6.0 to 7.0 pH range (slightly acidic to neutral) range. Some plants prefer a more acidic soil, while a few plants do best in soil that is neutral to slightly alkaline (or basic).

## Apply

Share the following with students: Normally, agricultural lime is used to increase the pH of acidic soils in which we want to grow plants. Lime contains mainly calcium carbonate. There are many benefits of applying the correct amount of lime. Liming an acid soil creates a favorable soil environment where plants can thrive. Most plants do well when the soil pH is between 6.2 and 6.8.

When acidic soil is neutralized by liming, soil nutrients are made more available for the plants to absorb through their roots. Usually when we see a micronutrient deficiency in a plant, it is not because there is not enough of the nutrient in the soil, it is because the soil pH has limited the availability of that nutrient.

Check out the provided table to review ideal soil pH for common trees and shrubs, fruit trees and vegetables. What plants would grow best with a pH of 4.9? 7.3?

## Life Skill(s)

6th Grade Head, Thinking  
*Wisely use resources to achieve a purpose.*

Identify the parts, steps and necessary sequence or order to achieve a goal.

7th Grade Head, Thinking  
*Learn to form ideas, make decisions, and think critically.*

Consider priorities, resources, needs, interests for a given problem or situation.

8th Grade Head, Managing  
*Wisely use resources to achieve a purpose.*

Determine the purpose of a specific type of record when recordkeeping for a project.

## ***Supplemental Information***

### ***Educational Standards Met***

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CHEM1.PS1: Matter and Its Interactions

8. Identify acids and bases as a special class of compounds with a specific set of properties.

CHEM2.PS1: Matter and Its Interactions

15. Explain common chemical reactions, including those found in biological systems, using qualitative and quantitative information.

PSCI.PS1: Matter and Its Interactions

12. Classify a substance as acidic, basic, or neutral by using pH tools and appropriate indicators.

Elements of this activity were adapted from <https://community.plantae.org/>



Name: \_\_\_\_\_

Experiment Hypothesis: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Materials:

Procedure:



Household Test Chemical	Hypothesized pH (1-14)	Initial Color	Indicator (Yes or No)	Final Color	Estimated pH (1-14) using Indicator Guide	Classification: Acid Neutral Base
Hydrogen peroxide						
Baking soda						
Laundry detergent						
Lemon juice						
Lemon-lime soda						
Vinegar						
Water						
Ammonia						

Data Collection:



Results:

Conclusions:

Application:



Farmer Mike wants to begin growing new plants for sale at the local farmers market. He has two fields. In one field the soil has a pH of 4.9. The other field has a pH of 7.3. Using the charts to the right, what plants would grow best in each of his fields?

Trees and Shrubs	Soil pH
Azaleas	4.5-6.0
Crape Myrtle	
Fruit Plants	Soil pH
Apple	5.5-6.5
Blueberry	4.5-5.5
Cherry	6.5-8.0
Plum	6.5-8.5
Raspberry, black	5.5-7.0
Raspberry, red	6.0-7.5
Strawberry	5.5-6.5
Grapes	5.5-7.0

Vegetables	Soil pH
Asparagus	6.0-8.0
Beans	6.0-7.0
Broccoli	6.0-7.0
Cantaloupe	6.0-7.5
Corn	5.5-7.5
Cucumbers	5.5-7.0
Lettuce	6.0-7.0
Onions	6.0-7.0
Peppers	5.5-7.0
Potatoes	4.8-6.5
Sweet Potatoes	5.2-6.0
Rhubarb	5.5-7.0
Spinach	6.0-7.5
Squash	6.0-7.0
Tomatoes	5.5-7.5