Soil and Water Experiment

Just like with foods and drinks, soils have a pH level that determines whether they are acidic or basic. Acids and bases are determined by measuring pH in a substance using chemistry. A **pH scale** is a measurement of how acidic or basic a substance is ranging from 0 to 14. Using the pH scale, the pH number 7 is neutral. Any number less than 7 indicates an **acid**. The lower the pH number is, the stronger the acid. Any number greater than 7 indicates a base. The higher the pH number is, the stronger the **base**. The level of acidity or alkalinity of a soil is one indicator of the soil's health and suitability for growing particular types of plants. Most plants prefer a slightly acidic to neutral soil, with a pH of 6 to 7, because that is the range in which all nutrients are readily available.

Soil, and all of Earth's other solid parts, together make up what is called the **geosphere**. As mentioned earlier, the pH of a soil affects what plants can grow there. This is just one way in which the geosphere interacts with the **biosphere**, which includes plants and all other life on Earth. Specifically, most plants prefer soil that is near neutral pH. There are particular varieties (strawberries, azaleas and rhododendrons, for example) that prefer acidic soil. Soil pH also influences how readily available many soil nutrients are to plants. The geosphere and biosphere are constantly interacting with each other, and with the **hydrosphere**, which includes all waters on Earth, such as in lakes, oceans, and the clouds.

In this science project, you will measure pH values of different types of soils, and you will see how the soil affects the pH of water that comes in contact with it.

Materials:

- 3 soil samples
- Ruler, metric
- Gallon ziplock bag (3)
- Tupperware (9)
- Permanent marker
- Small cups, at least 3-oz. (3)
- Tap water
- pH paper
- Soil pH meter
- Facial tissues *or* cotton balls (10)
- Clock, timer, or stopwatch
- Duct tape
- Coffee filters (18)
- Lab notebook

Pre-lab instructions:

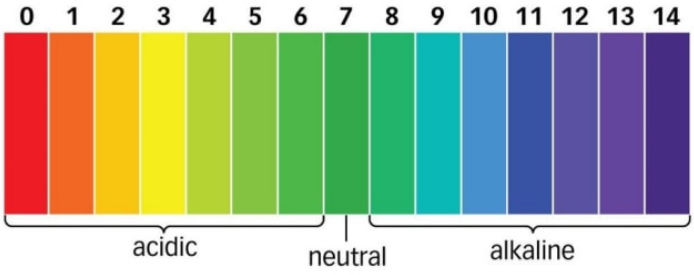
1. Choose three different places to collect soil samples. You could choose places in your yard, a park, a garden, or other location with easily accessible soil. Make sure to ask permission before collecting samples, and be careful when collecting samples near bodies of water or roadways. Picking places with soils that are as different as possible will allow you to see whether all **soil types** behave the same or if soil pH and the pH of water runoff changes with soil type. Here are some suggestions:
    a. Look for soils with different colors and textures.
    b. Look for differences in the kinds of plants growing in a place. Different plants prefer different kinds of soils, so plant populations can be a clue to differences in soil type.
    c. Try sampling different environments, such as a floodplain, beach, man-made garden, forest, or desert.
1. Take notes in your lab notebook about the sites. Include information about the general area (your yard, a park, the beach, a pine forest, etc.), and the kinds of plants (if any) growing in the area.
2. Gather enough soil to conduct three experiments. Remove the top 5 centimeters (cm) of the soil before collecting samples so you do not get any plants or surface roots in your samples. Also remove any stones or other objects from the sample
    a. Put each sample in a gallon bag. You will need around 2 to 3 cups of soil for each sample, depending on the size of your containers. Add soil to your containers until the soil is 15 to 20 cm deep.
    b. Label each bag using the permanent marker (e.g., "Soil from the riverbank, sample," "Soil from the garden, sample," etc.).

Directions:

1. When you are ready to start testing your samples, fill one of the small cups with about 4 cm of tap water. Use pH paper to measure the pH of the tap water, and record that value in your notebook. Then discard the water (use it to water a plant, etc.).
    a. Dip the piece of pH paper in the water, and then compare the color of the pH paper with the color scale below. Find the closest match to the color of

the pH paper; the pH value associated with that color is the pH of your water sample.

b. *Note:* You are investigating how the pH of water changes as it interacts with soil. To know how the soil *changes* the pH of water, you have to know the pH of the water *before* it mixes with the soil



2.

Water pH *before* experiment	

3. Read the instructions for your soil pH meter to learn how to use it properly. Make sure you follow any instructions for calibrating the pH meter before using it.
4. Separate your three soil samples into 9 tubs and label each with the location and sample number. (example: Garden #1, Garden #2, etc.)
5. Use the soil pH meter to measure the pH of each of the nine soil samples and enter into the data table.
6. Clean the soil pH meter.
7. Now you will investigate how the pH of water changes after it interacts with the soil samples for 1 hour. First, add more water to **<u>one</u>** of the soil tubs from each site (sample #1), until the soil is completely saturated and a layer of water about 1 cm deep forms above the surface of the soil.
8. Put the lids on and securely seal the lid with a piece of duct tape. Mix each of the tubs thoroughly by covering the cap with your hand and then vigorously shaking the tub for one minute.
    a. **Warning:** Make sure the cap is securely sealed with duct tape and that your hand covers the cap as you shake the tub. The muddy mixture of soil and water will make a big mess if it escapes the sediment tub. So, shake the tubs vigorously, but cautiously. It may be best to do this step outside.
9. Write the time on the duct tape using a permanent marker. Make sure it is dry before writing on it. You will come back to these samples in one hour.

10. Meanwhile, prepare three runoff-filtering containers.
    a. Put a coffee filter on top of the three, empty small cups.
    b. For each cup, fold the edges of the coffee filter over the edges of the cup and tape the folded-over edges to the outside with duct tape. Make sure to leave the top surface of the filter un-taped.
11. After the sediment tubs have sat for one hour, remove the duct tape and cap slowly from the tubs. Slowly and carefully pour the water from the tubs onto the filters over the runoff-filtering containers. The water from each sediment tub should go into its own container, and you should keep track of which runoff samples are in which runoff-filtering containers. It is okay if some soil comes out while you are pouring off the water—that is why the filter is there! Let the water percolate through the filter.
12. Once most of the water from the soil in the sediment tubes has been filtered, re-cap the sediment tubes.
13. Carefully remove the filter paper from the runoff-filtering containers by removing the tape and holding the filter by its edges, being careful not to allow soil or unfiltered water to fall into the filtered water.
14. Use pH paper to measure and record the pH of the filtered run-off water. Record the pH values in the table, being sure to note which values correspond to which soil samples. Rinse out the cups when you are done.
15. Calculate the difference in the pH of the tap water you measured in step 2 and the pH of each runoff you measured in step 14. This is how much the pH of the water changed after mixing with the soil for one hour. Record the difference in the data table in your lab notebook.
16. Repeat steps 9–17, but let the soil and water mix for one day and then two days, instead of one hour. You will need to vigorously shake the sediment tubes every few hours to re-mix the soil and water.

Sample (location and #)	**Tap water pH** (From step 2)	**Runoff water pH** (pH level of runoff water from step 14)	**Change in water pH** (Difference between tap water and runoff)	**Initial soil pH** (Record the pH of soil before experiment)

Questions:

1. How did the pHs of different soil types compare to each other?

2. Did any of the soils change the pH of the water? If so, by how much and how is that affected by the length of time the water mixes with the soil?