

## OVERVIEW

### Soil Analysis Lab AP Environmental Science

Soil is one of the earth's most important, yet least appreciated, resources. It performs a valuable role in land ecosystems. In order for a community of producers and consumers to become established on land, soil must be present. Furthermore, soil quality is often a limiting factor for population growth in such systems. Soil is a complex mixture of inorganic materials, organic materials, microorganisms, water and air. Its formation begins with the weathering of bedrock or the transport of sediments from another area. These small grains of rock accumulate as a layer on the surface of the earth. There they become mixed with organic matter called humus, which results from the decomposition of the waste products and dead tissue of living organisms. The soil formation process is very slow (hundreds to thousands of years), so it can be very detrimental to a community if the soil is lost through erosion or its quality degraded in any way. Soil contains important primary plant nutrients such as nitrogen, potassium and phosphorus. Water and air are also trapped in its pore spaces. These are all necessary ingredients for the growth of plants. In this lab activity you will determine textural and compositional characteristics of a soil sample as well as chemical characteristics of your soil sample.

1. **(day 1)** You will first determine the soil texture. This is a measure of the proportions of sand, silt, and clay in the soil. You will shake a soil and water mixture in a graduated cylinder and allow the sand, silt and clay to settle out in separate layers.
2. **(day 2)** Next you will use a commercial soil testing kit to determine **soil pH**. This is an important factor in determining soil fertility. Most plants prefer a certain soil pH range. You will then use the soil testing kit to determine the content of three plant nutrients: **nitrogen, potassium and phosphorus**. These are the primary macronutrients needed by plants. They can become depleted in soils due to human activity such as farming, runoff, or excess irrigation.
3. Finally, you will determine the overall health of the soil and clean up the lab.

## LAB EQUIPMENT AND MATERIALS

A list of equipment and materials needed to complete this activity is given below.

Equipment	Amount Needed
Soil test kit	1
Graduated cylinder (50 100ml)	1
Materials	Amount Needed
Soil sample	100-200ml
Plastic wrap (10 cm x 10 cm)	1 square
Rubber band	1
Drying Paper	1 sheet

## LAB PROCEDURE

### Hints for a successful lab:

- Plan your time wisely. Some activities require a sample to sit for ten to thirty minutes. Begin a new activity while waiting for another activity to finish.
- Read the instructions with the soil testing kit carefully.
- Do not put soil down the drain. It will clog the pipe.

### Prepare the soil samples

1. Remove about **40-50 mL** of the soil sample and set it aside for determination of the soil texture **(day 1)**.
2. Spread out the rest of the soil onto a sheet of paper to dry for chemical analysis **(day 2)**
3. Remove unwanted foreign material from the soil such as twigs, leaves, and stones.
4. Crush the soil gently to break up any clumps.
5. Dry the soil dry until it is ready to be used.

## Determine soil texture (day 1)

Soil is composed of particles that are categorized into groups according to their size, as shown in the table below. One method of classifying soils is to measure the relative amounts of sand, silt, and clay in a soil sample, then use a soil triangle to determine the soil type. In this lab, the textural classification of a soil sample will be determined by measuring the relative amounts of sand, silt, and clay particles, then using a soil triangle to determine the soil type. The comparative volumes of sand, silt, and clay will be determined based upon the fact that the different sized particles will settle out of a mixture at different rates.

<b>Clay</b>	<b>&lt; 0.002 mm</b>
<b>Silt</b>	<b>0.002 – 0.06 mm</b>
<b>Sand</b>	<b>0.06 – 2.0 mm</b>
<b>Gravel</b>	<b>&gt; 2.0 mm</b>

1. Place a **40 to 50 mL** of soil sample in the graduated cylinder.
2. Add water until the total volume of soil and water is about **80-100 mL**.
3. Cover the top of the graduated cylinder with a piece of plastic wrap and secure it with a rubber band.
4. Invert the cylinder several times until the soil is thoroughly suspended in the water. You may have to shake the cylinder to mix the water and soil thoroughly.
5. Place the cylinder on the table and let the soil material settle for at least **30 minutes**. The different soil materials will settle to the bottom at different rates depending upon their particle sizes: sand size > silt size > clay size.
6. **Estimate and record the volume of the sand, silt and clay layers** using the marks on the graduated cylinder. There should be at least three reasonably distinct layers in the graduated cylinder representing sand (bottom), silt (middle) and clay (top). There may also be a dark humus layer above the clay layer, or possibly floating on top of the water.
7. Be sure to record the volumes of the three layers and the total of volume of your sample, and **calculate the percent composition by volume for each layer**.

**Determine soil pH (day 2)**→The pH of soil is an important factor in determining which plants will grow because soil pH controls which nutrients are available for plants to use. The actions of plants, animals, and microbes that inhabit soil, along with physical factors, especially the characteristics of rainfall in the area, affect soil pH. Contrary to popular belief, rainwater does not have a pH of 7.0. As raindrops fall through the troposphere, carbon dioxide (CO<sub>2</sub>) is absorbed and dissolves in the rainwater, as a result the raindrops become acidic as CO<sub>2</sub> reacts with water to form carbonic acid (H<sub>2</sub>CO<sub>3</sub>), as shown (**CO<sub>2</sub> + H<sub>2</sub>O → H<sub>2</sub>CO<sub>3</sub>**). Since air has always contained CO<sub>2</sub>, rain has always been acidic. Today, the pH of rain can be 5.0 or lower if it is contaminated with oxides of sulfur and nitrogen which can form sulfuric and nitric acids respectively. In this lab activity, the pH of a soil sample will be determined.

## Materials

1. Use soil the dried soil that you previously placed on the drying paper.
2. Determine the pH of the soil following the procedure provided with the soil test kit. Note: During this test you must allow the soil to settle for about ten minutes.
3. **Record your pH data**.

## **Determine primary soil nutrients (day 2)**

1. Use soil on drying on the paper for this test.
2. Determine the nitrogen, potassium and phosphorous contents of the soil sample following the procedure provided with the soil test kit. Note: During each of these tests you must allow the soil to settle for about ten minutes.
3. **Record your results for the levels of nitrogen, potassium, and phosphorus**.

## Cleanup lab

1. Dump unused soil in an appropriate area outside or in provided container.
2. Soil used for the chemical tests should be placed in an appropriate area outside or in provided container. **Do not put soil down the sink!**
3. Return equipment and soil test kit materials to your teacher.

**LAB REPORT/ ANALYSIS QUESTIONS** Provide answers to the following questions using complete sentences.

1. The proportions of what three particles are used to determine soil texture? Which of these particles has the smallest surface area? Which has the largest?

2. USING THE SOIL TEXTURE TRIANGLE (FIG. 1), TO DETERMINE THE TYPE OF SOILS WITH THE FOLLOWING PARTICLE SIZES

a. 20% silt, 10% clay, 70% sand	b. 30% sand, 10% clay, 60% silt
c. 10% silt, 50% sand, 40% clay	d. 30% clay, 30% sand, 40% silt
e. 40% sand, 10% silt, 50% clay	f. Determine the soil type for your sample based on your % volumes.

3. Looking at the Soil Texture Triangle (Fig. 1), which soil type has the greatest: a. water retention ability? b. water percolation rate?

4. What role does humus play in soil fertility?

5. Why is pH such an important aspect of soil fertility?

6. What are some natural sources of the nitrogen, potassium and phosphorous found in soil?

7. How are the three primary plant nutrients used by living organisms?

8. By what process is atmospheric molecular nitrogen (N<sub>2</sub>) converted into a form that plants can readily absorb through their roots? What form of nitrogen is this?

9. What are some possible sources of error in this experiment?

10. Evaluate the fertility of the soil used in this lab activity based upon your results.

11. What types of vegetation does soil of the type and pH you sampled best support?

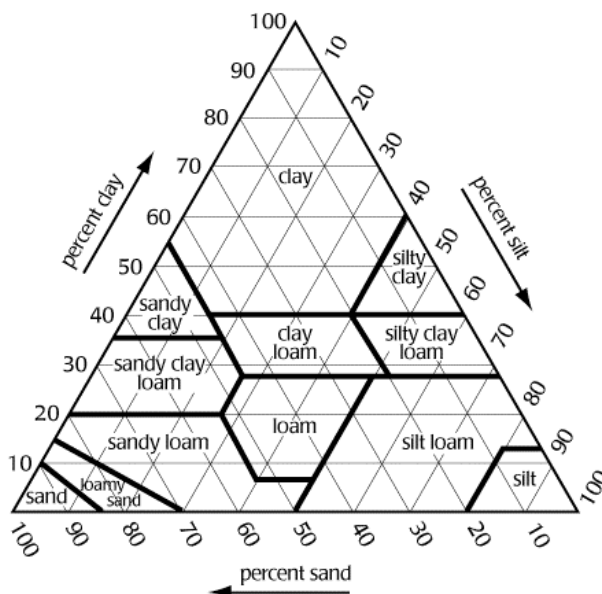
**Procedure for Use of the Soil Triangle**

The soil triangle is used to determine textural classes of soil from the percentages of sand, silt, and clay in the soil.

To determine soil texture using the soil triangle, the lines from each side must be extended in the correct direction. Proceed as follows:

- ☒ Clay—extend line horizontal from the percent clay (parallel with side labeled sand)
- ☒ Silt—extend line downward from percent silt at 60° (parallel with side labeled clay)
- ☒ Sand—extend line upward from percent sand at 120° (parallel with side labeled silt)

For example, if a soil is 40% sand, 30% silt, and 30% clay, the texture is clay loam.



**Figure 1**