APES- Soil Lab

Unless you are a farmer or gardener, you probably think of soil as "dirt" or something you do not want on your hands, clothes or carpet. Yet, your life and the lives of most other organisms depends on the soil.

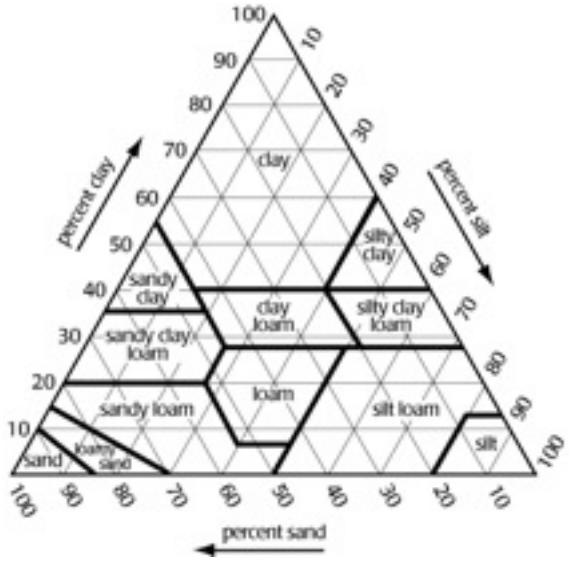
Soil is not only the basis of agricultural food production, but it is essential for the production of many other plant products such as wood, paper, cotton and medicine. In addition, soil helps purify the water we drink and is important in the decomposition and recycling of biodegradable wastes.

Nations, including the United States, have been built upon the riches of their soils. Yet, since the beginning of agriculture, people have abused this vital, potentially renewable resource. In fact, entire civilizations have collapsed because of mismanagement of the topsoil that supported their civilizations. Today, we are not only facing loss of soil from erosion, we are also depleting nutrients in some soils and adding toxins to others.

Soil is a complex mixture of inorganic materials, organic materials, microorganisms, water and air. Its formation begins with the weathering of bedroom 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 is 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.



Clay	< 0.002 mm
Silt	0.002 – 0.06 mm
Sand	0.06 – 2.0 mm
Gravel	> 2.0 mm

Part I: Soil Texture

Soil is composed of particles that are categorized into groups ***according to their size***, as shown in the table shown. 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.

Materials

- ☐ safety goggles
- ☐ lab apron
- ☐ 250-mL beaker
- ☐ distilled water
- ☐ 100-mL graduated cylinder
- ☐ rubber stopper for cylinder
- ☐ Calgon
- ☐ soil sample

Procedure

1. Bring in approximately 200 grams (1 cup) of soil from around your home.
2. In a group of four make and share a 5% Calgon solution as follows. Dissolve 10 g of Calgon in 200 mL of distilled water to make approximately 200 mL of 5% Calgon solution.
3. Add approximately 25 mL of soil to a 100-mL graduated cylinder. Add 5% Calgon solution to fill the cylinder to the 50 mL mark. Mix well (until all of the soil has been moistened) and allow the mixture to stand for 15 minutes.
4. Insert a rubber stopper in the graduated cylinder, wrap a paper towel around the stopper, and by inverting the cylinder, mix the solution for 10 minutes. Keep a hand over the stopper to secure it while mixing. Do not force the stopper into the cylinder to prevent leaking, as the cylinder may break; some of the mixture will leak out of the cylinder this is unavoidable.
5. Label the cylinder and leave it undisturbed for 23 hours.
6. After 23 hours, the lines that divide the sand, silt, and clay columns will be visible. Sand will be on the bottom, silt in the middle, and clay on the top. **Measure and record the volume of the sand column, the volume of the silt column, the volume of the clay column, and the total volume of soil in the cylinder**
7. Calculate and record the percent sand, silt, and clay in the soil sample.
8. Use the soil textural triangle to **determine the texture of the soil sample.**

Part II: Soil pH

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_2) is absorbed and dissolves in the rainwater, as a result the raindrops become acidic as CO_2 reacts with water to form carbonic acid (H_2CO_3), as shown below.

$$CO_2 + H_2O \text{ ----> } H_2CO_3$$

Since air has always contained CO_2, 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

- ☐ safety goggles
- ☐ 100-mL beaker
- ☐ pH test
- Plastic Fork
- ☐ balance

Procedure

1. Weigh out 20g of soil in a 100-ml beaker.
2. Add 40 mL of distilled water and stir for 30 seconds every 3 minutes for 15 minutes.
3. After the final stir of the soil mixture, remove the fork, and allow the mixture to settle for 5 minutes.
4. Carefully, measure and record pH of the liquid phase of the soil-water mixture using the pH test

Postlab Questions—Write out and respond to the following questions.

1. Use the soil triangle 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. 60% clay, 10% sand, 30% silt
    f. 40% sand, 10% silt, 50% clay
2. List and describe three ways in which soil pH affects an ecosystem.
3. What types of vegetation does soil of the type and pH you sampled best support?
4. What would be the ideal type and pH of soil to have around a home?
5. What would be the ideal type and pH of soil for agriculture?
6. How do farmers adjust the pH of soils?

Part III: Classification of Soil Texture by Hand

Background: There are a variety of methods used to determine that type of soil you have. Some people simply pinch soil between their fingers and thumb and if it feels gritty, it contains a lot of sand. If it feels sticky and can be molded into a ball, it contains a lot of clay. If it feels quite smooth, almost like flour, it contains a lot of silt.

A: Using the method described above, **try to classify your soil** as mostly sand, mostly silt or mostly clay. How did you classify your soil based on this "by hand" method? What lead you to this conclusion?

B: Now use the **dichotomous key t**o classify your soil. What soil texture would you classify your sample based on this method?

C: Do it again with the flow diagram- how would you classify your soil now?

D: Did your answers to all of the methods agree with each other? *Why or why not?*

Dichotomous Key

Question	***Ans.***	
1 Does the soil feel or sound noticeably sandy?	***YES***	***Go To Q.2***
	NO	***Go To Q.6***
2 Does the soil lack all cohesion?	***YES***	***SAND***
	NO	***Go To Q.3***
3 Is it difficult to roll the soil into a ball?	***YES***	***LOAMY SAND***
	NO	***Go To Q.4***
4 Does the soil feel smooth and silky as well as sandy?	***YES***	***SANDY SILT LOAM***
	NO	***Go To Q.5***
5 Does the soil mold to form a strong ball which smears without taking a polish?		
	YES	***SANDY CLAY LOAM***
	NO	***SANDY LOAM***
6 Does the soil mold to form an easily deformed ball and feel smooth and silky?		
	YES	***SILT LOAM***
	NO	***Go To Q.7***

7 Does the soil mold to form a strong ball which smears without taking a polish?

	YES	***Go To Q.8***
	NO	***Go To Q.10***

8 Is the soil also sandy?	***YES***	***SANDY CLAY LOAM***
	NO	***Go To Q.9***

9 Is the soil also smooth and silky?	***YES***	***SILTY CLAY LOAM***
	NO	***CLAY LOAM***

10 Does the soil mold like plastic, polish and feel very sticky when wetter?

	YES	***Go To Q.11***
	NO	***Start again unless organic***

11 Is the soil also sandy?	***YES***	***SANDY CLAY***
	NO	***Go To Q.12***

12 Is the soil also smooth and buttery?	***YES***	***SILTY CLAY***
	NO	***CLAY***

There are a variety of methods to determining what type of soil you have. Some people simply pinch moist soil between their finger and thumb. If it feels gritty, it contains a lot of sand. If it feels sticky and can be molded into a ball, it contains a lot of clay. If it feels quite smooth, almost like flour, it contains a lot of silt. The best soil for plant growth is a "loam" which contains a high amount of silt mixed with a low amount of clay and a middle range of sand.