## *Overview

The ability for water to infiltrate a soil is determined by the properties of a particular soil. In this activity, students will investigate soil properties by performing infiltration experiments and determining texture.

## Objectives

By the end of this activity, students will be able to:

- understand how different materials affect how fast water moves through a soil column
- determine the texture of different soils

## Subject

Science

## Grade level

4-12th

## Length of activity

45 min

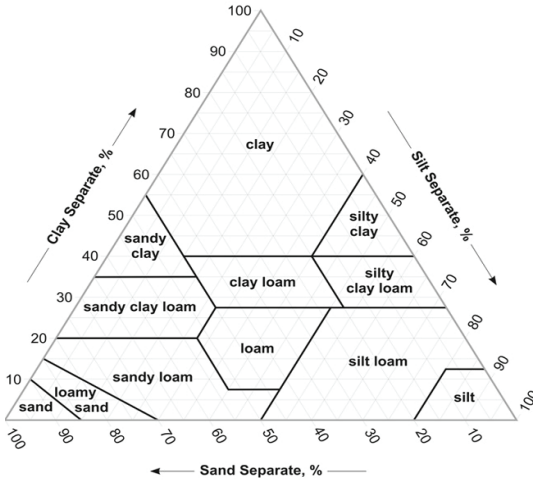
## Activity location

Inside or outside the classroom

## Materials

2 liter bottles, window screen, rocks, sand, clay, potting soil, soil from outside the school grounds.

*Activity adapted from Globe




USDA soil texture triangle

# Soil Infiltration and Texture

## Introduction

**Soil** is made of a mixture of broken down pieces of rock (mineral particles of different sizes: sand, silt and clays), organic material (dead and living organisms: bacteria, decomposed plants and animals), air and water. The properties of a soil affects how water moves through the ground, which in turn affects the amount of water that can be stored as groundwater, and the types of vegetation that can grow. There are both physical and chemical properties which make up a soil.

Physical properties include: **color**, **texture** (how much sand, silt and clay), **porosity** (the amount of air space between grains), **soil structure** (how the grains are arranged), **permeability** (how fast liquids move through soil), and **bulk density** (the mass of soil per unit volume). All these properties besides color determine how fast or slow water can move through soil, called **infiltration**. A few chemical properties of soil include the amount of organic matter, carbon, nitrogen found in a soil. Scientists use specific techniques to determine the properties of soil, performing them either in the field or the lab.

In this activity, students will be introduced to these additional key terms:

**Groundwater** - water that infiltrates and collects underground

**Soil texture** - the proportion of sand, silt and clays in a soil

**Sand** - soil grains 0.05 - 2 mm size

**Silt** - soil grains 0.002 - 0.05 mm size

**Clay** - soil grains which are > 0.05 mm size

**Loam** - a soil with a combination of sand, silt and clay

The first part of this activity is designed to illustrate how different soil types affect the movement of water through the soil column. The second part will provide a hands-on example of how soil texture is analyzed in a field environment.

## Materials

For this activity, you will need 1 soil column per group of 3-4 students.

- 2-liter bottle, remove label and cut off bottom 5 inches. The bottom part will be used to hold bottle.
- Potting soil
- Soil from the school grounds
- Gravel
- Sand
- Window screen, cut in a circle to fit at the bottom of the 2 L bottle
- Water
- Stop watches

## Activity Description - Soil Infiltration

1. Choose a soil, such as play sand, mortar clay, potting soil, top soil from the school yard, or gravel.
2. Invert the empty 2-liter bottle with the bottom cut off. The bottom section is used to catch the water that passes through the soil.
3. Place the circle of screen over the mouth of the bottle. Add a layer of play sand over the screen, about 3 cm, to prevent the screen from getting clogged. Fill bottle with your selected soil leaving 10 cm of headspace.
4. Place soil column over the bottom section of the bottle (Fig 1).
5. Make a prediction as to how fast or slow you think the water will move through the column.
6. Pour water onto the top of your soil column, beginning with 100 mL. Have students start stopwatches, recording the time when liquid begins to come out of the bottom.

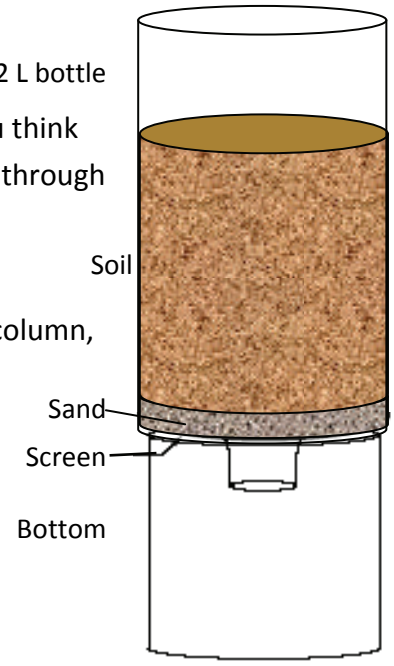


Fig 1. Completed soil column

7. Ask students the following questions, having them record the answers and their general observations:

⇒ Does water come out of the bottom, how long does it take?

⇒ Is the water clear or does it have some color?

7. If no water comes out of the bottom, add another 100 mL of water into soil column. Repeat # 6.
8. Switch soils with other groups and repeat the experiment.

⇒ How do the different soils affect the flow of water?

⇒ How might the presence of vegetation on the surface affect infiltration and/or water movement?


## Soil Texture - Background

A simple preliminary analysis method used by scientists to obtain information about a soil is the hand texture test. This test can be done in the field with no equipment other than the scientist's hand.

Typically soil scientists perform a field texture test first to get a sense of the distribution of grain size in the soil. By knowing the sand, silt and clay content of soil, scientists can determine how well certain plants will grow, how fast or slow water will infiltrate into the ground, and how stable the ground is for construction.

The distribution of sand, silt and clays play an important roll in how water will infiltrate into the soil. From the previous experiment, you should have determined that gravel and sand allow water to infiltrate much faster than potting or school ground soil. Based on the hand texture, students can use the USDA soil texture triangle to determine the proportion of sand, silt and clays in a soil. Larger fractions of sand will allow water to pass quickly, whereas larger fractions of silt and clay will allow water to pass slowly.

## Activity Description - Soil Texture

1. Review or discuss what a soil is made of, differentiating between physical and chemical properties.
2. Obtain a small handful of soil dug up from the schoolyard.
3. With your group, use the soil texture flow chart provided to determine the texture of the soil.
4. Did everyone come up with the same texture?
5. Look at the USDA soil texture triangle. Based on your texture, write down the % sand, silt and clay.
6. Repeat the texture test 3 times, recording the texture and % sand, silt and clay. It is difficult to get an accurate texture reading by only performing this test once. It may take up to 10 times to get a good feel for determining hand texture.
7. On the board, write down all the different textures students came up with. Is there an absolute answer for soil texture? Ask students why their textures may be different.
8. Ask students how fast water will move through these different soil textures, thinking back to the infiltration experiment.
9. If time permits, try creating a "soil" with the sediments provided. Try to guess what the texture is of your created soil and compare it to your hand texture result.

## Assessment

⇒ Ask students to write down all the different types of materials used in the infiltration experiment (sand, gravel, potting soil, school ground soil). Have them rank them by how fast or slow water infiltrates through these materials.

⇒ Using the USDA soil texture triangle, have students write down 3 different textures and their % of sand, silt and clay.

⇒ Ask students to define infiltration and soil texture on a piece of paper.

⇒ points.


## Extensions

⇒ Take students out into the school yard with baggies and collect soil samples from different areas, measure texture and perform an infiltration test.

⇒ Use GPS or maps to mark locations of soils. You can use Google Earth to upload your sample location.

## Resources

Main USDA soil web page: http://soils.usda.gov/

USDA Soil texture calculator: http://soils.usda.gov/technical/aids/investigations/texture/

USDA soil texture by feel flow chart and triangle :http://soils.usda.gov/education/resources/lessons/texture/

NASA soil science education: http://soil.gsfc.nasa.gov/

Minnesota DNR free Garmin GPS program to download points and use in Google Earth

http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html

## California State Science Standards

**4-8th grade**

4th: 6.c, 6.d, 6.f

5th: 6.c

**High school**

Investigation and Experimentation: 1.a