LAB 11

Lab Handout

Lab 11. Soil Texture and Soil Water Permeability: How Does Soil Texture Affect Soil Water Permeability?

FIGURE L11.1

Soil particle types and sizes

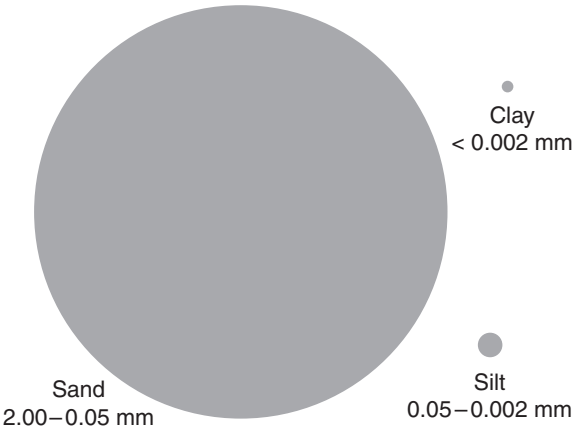
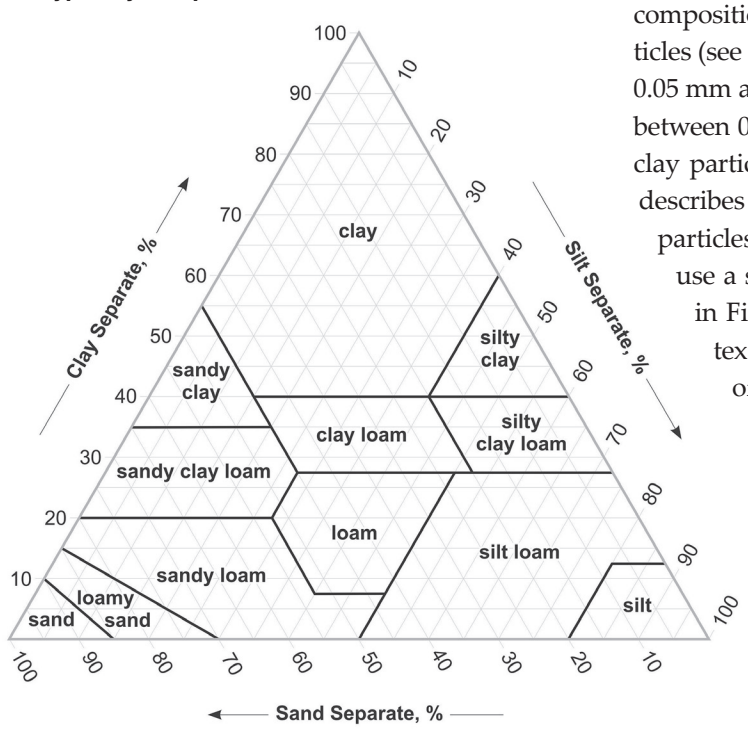


FIGURE L11.2

Soil types by composition



Introduction

When it rains, water lands on the ground and flows into streams, rivers, gutters, and sewers. It can also soak into the ground. The ground is made up rock and soil. Soil is composed of many small particles. In between these particles are pores. Water can flow into and through these pores. *Soil water permeability* is defined as the rate at which water can flow through the pores of a soil. Rainwater tends to seep into soils that have high soil water permeability and tends to pool on top of or flow over soils with low soil water permeability. There are several different physical properties of soil that can affect the rate at which water flows through it.

One of the physical properties of soil that affects soil water permeability is *soil texture.* Soil is composed of small particles that vary in size, shape, and chemical composition. There are three main types of soil particles (see Figure L11.1): (a) sand particles are between 0.05 mm and 2.0 mm in diameter, (b). silt particles are between 0.002 mm and 0.05 mm in diameter, and (c). clay particles are smaller than 0.002 mm. *Soil texture* describes the relative proportion of sand, silt, and clay particles by weight in soil sample. Earth scientists use a soil texture triangle, such as the one shown in Figure L11.2, to classify soils according to 12 textural categories, based on the proportions of each particle type in the soil sample. For example, a soil that is composed of 30% clay, 10% silt, and 60% sand is classified as a *sandy clay loam;* whereas a soil that consists of 20% clay, 40% silt and 40% sand *is classified as a* loam.

Geotechnical engineers are often concerned about the water permeability of soil because they

are responsible for building structures on or in the ground, and the rate at which water flows through soil can have an adverse effect on these structures. Geotechnical engineers must therefore understand how the physical properties of soil affect the rate at which water flows through it. In this investigation, you will have an opportunity to examine how soil texture, which is an important physical property of soil, affects soil water permeability.

Your Task

Use what you know about soil composition; scale, proportion, and quantity; and the importance of tracking how matter moves into, through, and out of a system to plan and carry out an investigation to determine the relationship between soil texture and soil water permeability.

The guiding question of this investigation is, ***How does soil texture affect soil water permeability?***

Materials

You may use any of the following materials during your investigation:

Consumables

- Soil sample A
- Soil sample B
- Soil sample C
- Soil sample D
- 12 Coffee filters
- Paper towels

Equipment

- Safety glasses or goggles (required)
- Chemical-resistant apron (required)
- Gloves (required)
- Measuring spoon (15 ml)
- 1 Graduated cylinder (100 ml)
- 1 Graduated cylinder (50 ml)
- 1–4 Funnels
- 1–4 Beakers (each 250 ml)
- 1–4 Support stands
- 1–4 Ring clamps
- 1 Stopwatch
- 1 Wax marking pencil
- Electronic or triple beam balance
- Flowchart for soil texture by feel

Safety Precautions

Follow all normal lab safety rules. In addition, take the following safety precautions:

- Wear sanitized indirectly vented chemical-splash goggles and chemical-resistant, nonlatex aprons and gloves through the entire investigation (which includes setup and cleanup).
- Handle all glassware with care.
- Report and clean up any spills immediately, and avoid walking in areas where water has been spilled.
- Wash hands with soap and water when done collecting the data and after completing the lab.

LAB 11

Investigation Proposal Required? ☐ Yes ☐ No

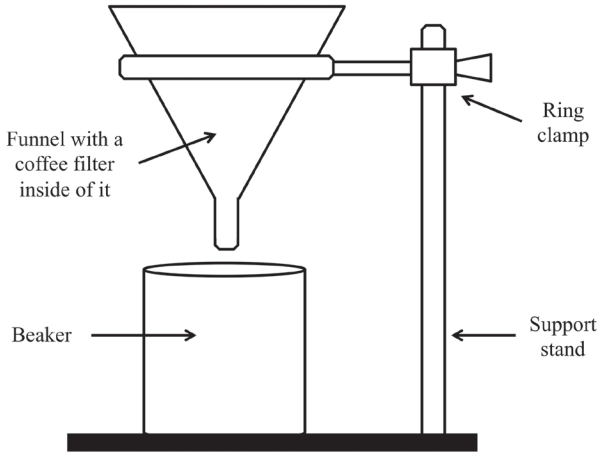
Getting Started

You can determine the rate at which water flows through a soil sample using the equipment illustrated in Figure L11.3. Once you have your equipment set up, you can place a sample of soil inside the coffee filter and then add water to the soil. The water will flow through the soil and the coffee filter and then land in the beaker. Your teacher will let you know where you can get samples of different types of soil.

Before you begin to design your experiment using this equipment, think about what type of data you need to collect, how you will collect the data, and how you will analyze the data.

FIGURE L11.3

Equipment needed to measure the rate at which water flows through a sample of soil



To determine *what type of data you need to collect,* think about the following questions:

- How can you track water flowing through soil?
- What information about a soil sample do you need to determine its texture?
- What information will you need to calculate a rate?
- What type of measurements or observations will you need to record during each experiment?
- When will you need to make these measurements or observations?

To determine *how you will collect the data*, think about the following questions:

- What will serve as your independent variable and dependent variable?
- How will you vary the independent variable during each experiment?
- What will you do to hold the other variables constant during each experiment?
- What types of comparisons will you need to make?
- What measurement scale or scales should you use to collect data?
- What will you do to reduce error in your measurements?
- How will you keep track of and organize the data you collect?

To determine *how you will analyze the data,* think about the following questions:

- What calculations will you need to make?
- How could you use mathematics to describe a relationship between variables?
- How could you use mathematics to document a difference between groups or conditions?
- What types of patterns might you look for as you analyze your data?
- What type of table or graph could you create to help make sense of your data?

Connections to the Nature of Scientific Knowledge and Scientific Inquiry

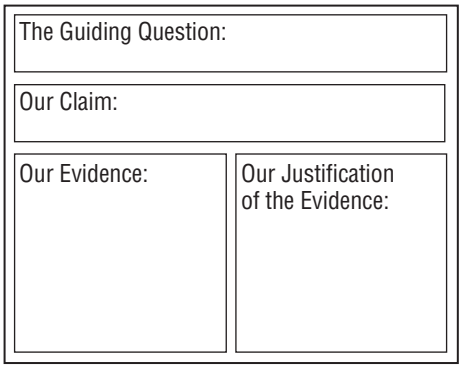
As you work through your investigation, be sure to think about

- the difference between observations and inferences in science, and
- how the culture of science, societal needs, and current events influence the work of scientists.

Initial Argument

Once your group has finished collecting and analyzing your data, your group will need to develop an initial argument. Your initial argument needs to include a claim, evidence to support your claim, and a justification of the evidence. The *claim* is your group's answer to the guiding question. The *evidence* is an analysis and interpretation of your data. Finally, the *justification* of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L11.4.

FIGURE L11.4
Argument presentation on a whiteboard



Argumentation Session

The argumentation session allows all of the groups to share their arguments. One or two members of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations to listen to and critique the other arguments. This is similar to what scientists do when they propose, support, evaluate, and refine new ideas during a poster session at a conference. If you are presenting your group's argument, your goal is to share your ideas and answer questions. You should also keep a record of the critiques and suggestions made by your classmates so you can use this feedback to make your initial argument stronger. You can keep track of specific critiques and suggestions for improvement that your classmates mention in the space provided.

Critiques of our initial argument and suggestions for improvement:

If you are critiquing your classmates' arguments, your goal is to look for mistakes in their arguments and offer suggestions for improvement so these mistakes can be fixed. You should look for ways to make your initial argument stronger by looking for things that the other groups did well. You can keep track of interesting ideas that you see and hear during the argumentation in the space below. You can also use this space to keep track of any questions that you will need to discuss with your team.

Interesting ideas from other groups or questions to take back to my group:

Once the argumentation session is complete, you will have a chance to meet with your group and revise your initial argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the best argument possible.

Report

Once you have completed your research, you will need to prepare an *investigation report* that consists of three sections. Each section should provide an answer for the following questions:

1. What question were you trying to answer and why?
2. What did you do to answer your question and why?
3. What is your argument?

Your report should answer these questions in two pages or less. You should write your report using a word processing application (such as Word, Pages, or Google Docs), if possible, to make it easier for you to edit and revise it later. You should embed any diagrams, figures, or tables into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid.