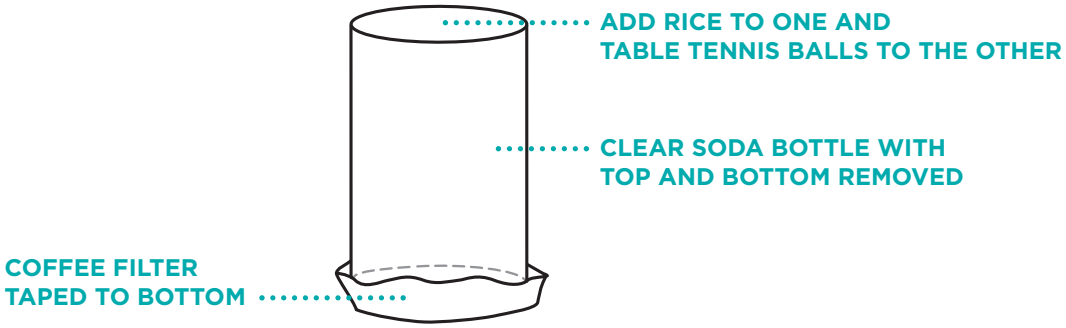
SPLENDID SOIL

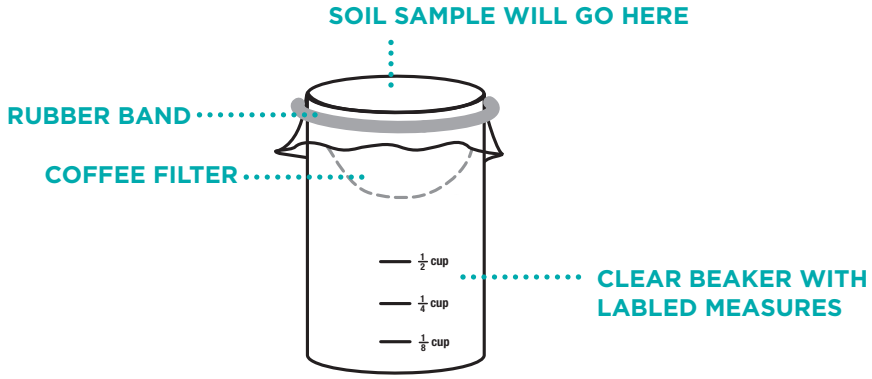
Teacher Preparation

Teacher Demonstration: Cut the top and bottom off of each 20-oz plastic soda bottle. Tape a coffee filter to the bottom of each bottle (make sure it is securely attached). Fill one bottle with rice and the other with table tennis balls. Make sure that both bottles are filled to the same height. See drawing below:



Student Activity: Each workstation should have a container of water and a half-cup measure, hand lens, a timing device, and 1/2 cup samples of sand and clay as listed under the materials section. Samples should be poured onto paper plates, and labeled. For grades 2 and 3, add an additional sample of topsoil.

Each station should also have two (grades K and 1) or three (grades 2 and 3) beakers or clear measuring cups prepared as follows: Set a coffee filter in the top of each graduated beaker (or measuring cup) and bend the edges of the filter around the edges of the beaker. Secure a rubber band around each coffee filter and beaker to hold the coffee filters in place. Make sure that the coffee filters extend deep enough into the beakers/cups so they form a "pouch" large enough for one soil sample in each, shown below:



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STEPS FOR *SPLENDID SOIL*

1. **Warm-up Activity:** Show the class the plastic bottles containing the rice and table tennis balls. Ask what they think will happen when you pour water over each. Ask which they think will drain better and why.

   Have two volunteers each hold one of the bottles over a graduated beaker in front of the class. Have two other volunteers pour water into each bottle at the same time. Students should observe that the water will drip slower from the rice than from the table tennis balls. Ask students why they think this happens.

   Tell students that soil is similar to the rice and table tennis balls in this demonstration. Some soil will hold water well, and some soil will drain water easily.

2. Distribute the *Splendid Soil* handout to students. Have each group of students find a workstation.

3. Tell the students that they are to use their sense of sight and a magnifying glass to examine the soil samples. Have each group take three to five minutes to examine the samples. What colors are they? Do the grains look large, or do they seem to be small and fine? What shape are the grains? Remind students to record all of their observations in the Soil Observations chart. Students can draw pictures of their soil samples and write words to describe them.

4. Next, have students use their sense of touch to observe the soil samples. Are they rough or smooth, sticky or grainy? Ask students to suggest words to describe the texture of the soils, and write these on the board to assist them in writing the words. Have students take three to five minutes to make and record their observations in the Soil Observations chart.

5. Have students compare samples, describing the samples relative to one another (e.g., "The sand feels rougher than the clay.").

6. Ask students to think about the demonstration with the rice and table tennis balls. What do they predict will happen when they add water to the clay and the sand? Which soil material will let water drain more easily? Have them record their predictions on the Student Handout.

7. Have a student from each group carefully pour each soil material sample into the coffee filter pouch of the prepared measuring cups.

8. Explain that students are going to pour water over each sample. They will measure the amount of water that drains through each soil material into the measuring cup.

9. Instruct students to perform the experiment. One student should measure 1/2 cup of water. The water should be poured, not dumped, onto the sample. Students should use a watch or clock with a second hand to wait three minutes for the water to drain. Have students record the amount of water that has drained from each soil sample after three minutes in the Soil Observations chart.

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10. Wrap-up Activity: Review the results of the activity with the students. Ask students which soil material had particles that were the largest and which were the smallest. Lead students to state that the sand had the largest soil particles while the clay had the smaller soil particles. Ask students which allowed more water to pass through it in one minute. Ask students if they see a relationship between the size of the soil particle and the amount of water that passed through the soil. Explain that larger soil particles drain quicker than smaller particles because the gaps between each particle are larger and allow water to pass through easier. Smaller, finer particles do not drain as well because they are more tightly packed. Review the answers to the questions on the Student Handout.

For grades 2 and 3, have students examine the topsoil sample as they did during Steps 3 and 4. Explain that topsoil is a combination of the different soil particles (as well as some other materials, like organic matter). Students may draw a Soil Observation chart similar to the one on the Student Handout to record their observations. Based on their observations, have students predict whether the soil will hold more or less water than the clay and the sand. Then have students repeat the procedure as they did in Steps 7 through 10. Have them compare the results to their predictions.

Splendid Soil Extension Activity

Have teams of students brainstorm combinations of different-sized materials that could placed in the coffee filter/graduated beaker set-up (such as rice, beans, marbles, coins, table tennis balls, etc). These combinations of materials represent the different-sized particles that make up soil. Tell teams that they are going to race each other to see whose "soil" absorbs more water. The teams will pour water over their "soil" and measure the amount of water that drains in a specific time. Have each team share their results. Students can create different combinations of soil and carry out numerous trials.

What is soil and why is it important?

Soil is a loose material found on Earth's surface. It is made of a combination of materials including sand, silt, clay, air, water, dead animal and plant material, and living organisms such as bacteria and fungi. Soil has many functions. It helps provide stability to the roots of a plant and with the water and nutrients it needs to survive. Soil absorbs water, keeping it from running off or flooding other areas. Soil also provides a habitat for many animals. Many plants require a particular balance of water that is retained by soil.

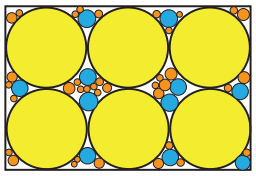
What are the different-sized soil particles?

There are many different types of soils. Soils are characterized in terms of grain size and composition. A soil particle is classified as **gravel** if it is between 2.0 mm and 64 mm. A particle is considered to be **sand** if it's between 0.05 mm and 2.0 mm in diameter. **Silt** particles range from 0.002 mm to 0.05 mm. Particles of **clay** have a diameter of less than 0.002 mm. Soil contains various proportions of different-sized soil particles. For example, if the soil has mostly larger sand particles, then the soil would be considered "sandy". If it has mostly smaller particles, it would be classified as "clayish," and so on.

What is the difference between porosity and permeability?

The **porosity** of soil refers to the total amount of empty space, or gaps, between soil particles. The amount of water that a type of soil can hold depends on its porosity. The porosity of a material depends on both the arrangement and shape of the particles. For example, a material made of particles that are stacked on top of each other is more porous that one made of particles that are offset from one another.

A material made of lots of different sized and shaped particles is less porous that one that is homogeneous.



(Images above are for reference only. Source: http://www.co.portage.wi.us/groundwater/undrstnd/soil.htm)

The size of the particles, however, does not affect the porosity.

The **permeability** of soil refers to how well the soil drains, or transmits fluids through it. Permeability is a function of the sizes of the pores and how connected the pores are. Although porosity and permeability can be related to one another, they are not necessarily linked. A material can be very porous, but if the pores are not connected or if they are too small, it is difficult for water to travel from one pore to another, and it is therefore not very permeable. A sample of silt could have the same porosity as a sample of gravel, but the silt will be much less permeable because the pores are much smaller and not as tightly packed.

Key Vocabulary

Absorb: to soak up

Clay: a collection of small, fine soil particles that are less than 0.002 mm in diameter; particles are too small to see without a microscope

Diameter: the length of a line that connects two points on the edge of a circular or spherical object and also crosses through the center of the object

Gravel: a collection of rocks that are between 2.0 mm and 64 mm in diameter

Sand: a collection of particles that are between 0.05 mm and 2 mm in diameter; particles can be seen with the naked eye

Silt: a collection of small, fine soil particles between 0.002 mm to 0.05 mm in diameter

Soil: a loose mixture of different size particles (such as sand, silt, and clay), organic material (such as decayed plants and animals as well as live organisms), water, and air, and various minerals; particles can be seen with a magnifying glass

Soil Observations

Type of Soil Material	How Does It Look?	How Does It Feel?	How much water drained?
Sand	[Answers will vary. Students may draw their soil or use words.]	[gritty and rough]	
Clay	[Answers will vary. Students may draw their soil or use words.]	[smooth, a little sticky]	

Answer the questions.

Which material drained the most water?

[Sand drained the most water.]

Which material absorbed the most water?

[Clay absorbed the most water.]

Which material was most similar to the table tennis balls in the demonstration? Why?

[Sand, because it had the larger grains.]

What material was most similar to rice in the demonstration? Why?

[Clay, because it had smaller grains.]

Blueberry plants have roots that do not like to be wet for very long. Jan wants to plant blueberries in her yard. What could she add to the soil to make sure water drains quickly through it?

[She should add sand, because it drains water better than clay.]

Name:

Date:

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