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Does This Hold Water?

by David Mitchell
AIMS Research Fellow

Topic

Soil and water

Key Question

How do different types of soil retain water?

Learning Goals

Students will:

1. compare how different soils retain water,
2. create and interpret graphs, and
3. compare results of a scientific investigation.

Guiding Documents

Project 2061 Benchmark

- *Objects can be described in terms of the materials they are made of (clay, cloth, paper, etc.) and their physical properties (color, size, shape, weight, texture, flexibility, etc.).*

NRC Standard

- *Soils have properties of color and texture, capacities to retain water and ability to support the growth of many kinds of plants, including those in our food supply.*

*NCTM Standards 2000**

- *Understand how to measure using standard and nonstandard units*
- *Select an appropriate unit and tool for the attribute being measured*

Science

Earth science
soils

Math

Measurement
volume
Graphing

Integrated Processes

Observing
Comparing and contrasting
Communicating
Collecting and recording data
Analyzing

Materials

For each group:

- three 6-oz Styrofoam cups
- three 10-oz clear plastic cups
- two 9-oz clear plastic cups
- sand, potting soil, topsoil (see *Management 1*)
- nine cotton balls
- graduated strips (see *Management 2*)
- colored pencils or crayons

Background Information

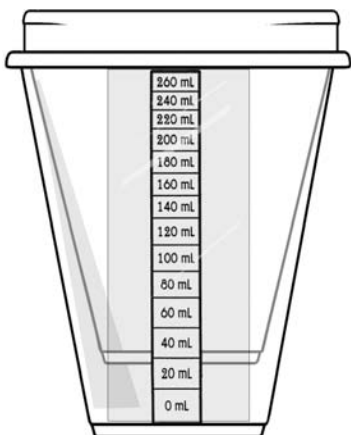
Soil texture is used to describe the proportions of different-sized particles in soil. The three particle sizes are sand, silt, and clay. Sand particles are the largest, silt particles fall in the middle, and clay particles are the smallest. The texture of soil is a very important property because it influences the soil's ability to hold water and air. The different particle sizes affect how well the soil drains. Sandy soils drain very rapidly as a result of the relatively large spaces between the particles. Soils with high clay content have very high water retention properties because there is relatively very little space between the particles. It is very rare for soils to have only one type of particle size. We will use topsoil in this activity. It is a mixture of the sand, clay, and silt.

Management

1. Builders' sand and topsoil can be purchased from landscape centers. Topsoil contains no humus (organic material). Topsoil will vary depending on source of origin. It will be a mixture of sand, silt, and clay.
2. Copy the graduated strips onto transparency film. Cut out the strips and tape them to the appropriate-sized clear plastic cups. If students have not read graduated scales such as these, take the time to practice by having them fill their cups to various levels and read the scales. On this scale, the measure is read above the line it represents. Notice that the spacings are not equal; this is a result of using a container with slanted sides.
3. Each group will need three graduated 10-oz cups and two 9-oz cups.

Procedure

1. Ask the *Key Question* and state the *Learning Goals*.
2. Distribute three Styrofoam cups to each student group. Have them put five small holes in the bottom of each cup.
3. Distribute the cotton balls. Direct the students to use three in each cup to make a layer on the bottom, covering the holes.
4. Tell the students to place 100 mL of sand in the first cup, 100 mL of potting soil in the second cup, and 100 mL of topsoil in the third cup.
5. Place each Styrofoam cup inside a 10-oz plastic cup that has the graduated strip attached to its side.



6. Guide the students in a discussion of what makes a fair test. Inform them that they will be adding 50 mL of water to each type of soil. Distribute the 9-oz graduated cups. Ask students where they would have to fill the cup to in order to have 50 mL of water. [About halfway between the line for 40 mL and 60 mL]
7. Tell them they will be timing to see when the first drops come through the holes in the bottom. Have students notice the clock dials on the student page. Ask them what they think the numbers represent. [seconds] Ask them how they think they would mark the clock dial if it took 20 seconds for the first drops to appear. [Make a mark at the top and a mark at 20. Use a line to connect each mark to the midpoint in the dial. Color in the wedge that they have drawn.]
8. Have each group test the three soils for how long it takes for the first drops to come out. Direct them to record the information on the student record sheet.
9. Direct the students to observe the three containers. Ask them what else they could record about the soil and water. (If no one suggests it, point out that they could also record how much water is in the bottom of the graduated cylinder).

10. Ask them how they could use subtraction to determine how much water was retained in each soil sample.
11. Direct the students to complete the graphs for each soil type.
12. Discuss any differences between the data collected by the different groups.

Discussion

1. How much time did it take for the first drop of water to drain through the soil? Was it the same amount of time for each cup? Explain.
2. Which type of soil seems to hold the most water? How could you justify this answer?
3. Who would want to know about how much water a certain type of soil is able to retain?
4. Why is it important to record observations in science?
5. How did the graphs help in this activity?
6. Did every group get exactly the same results? Why is this important to talk about?
7. What are you wondering now?

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Does This Hold Water?

Graduated Strips

Copy these strips on overhead transparency film. Cut them apart and tape each strip to the appropriate-sized plastic cup.

240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL
220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL
200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL
180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL
160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL
140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL
120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL
100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL
80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL
60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL
20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL
0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL

9 oz

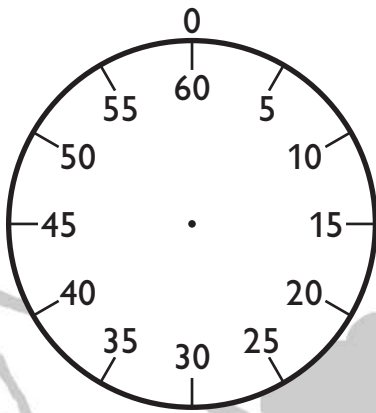
260 mL	260 mL	260 mL	260 mL	260 mL	260 mL	260 mL	260 mL	260 mL	260 mL	260 mL	260 mL	260 mL
240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL	240 mL
220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL	220 mL
200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL	200 mL
180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL	180 mL
160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL	160 mL
140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL	140 mL
120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL	120 mL
100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL
80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL	80 mL
60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL	40 mL
20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL	20 mL
0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL	0 mL

10 oz

Does This Hold Water?

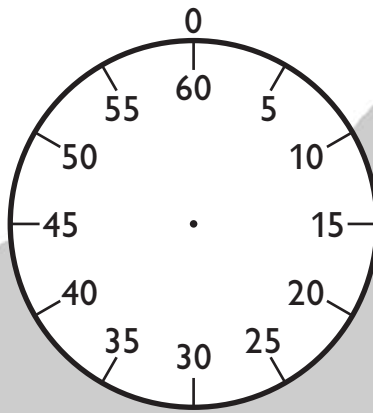
Record the time it takes for the first drops to appear.

Sand



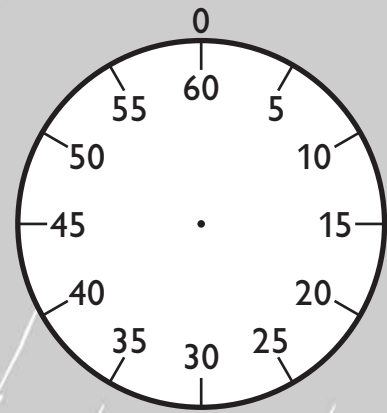
_____ sec.

Potting Soil



_____ sec.

Topsoil



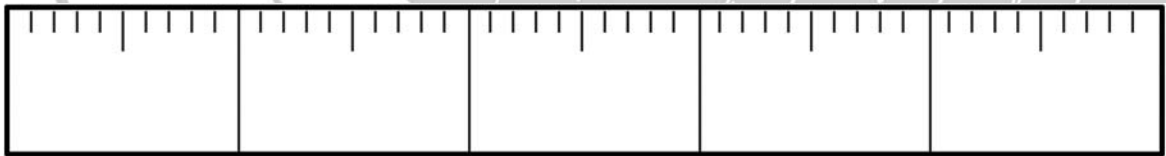
_____ sec.

Water Strips

Record the amount of water in the cups after 10 minutes.

10 mL 20 mL 30 mL 40 mL 50 mL

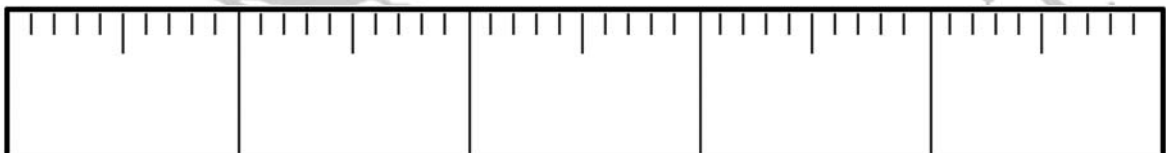
Sand



Potting Soil



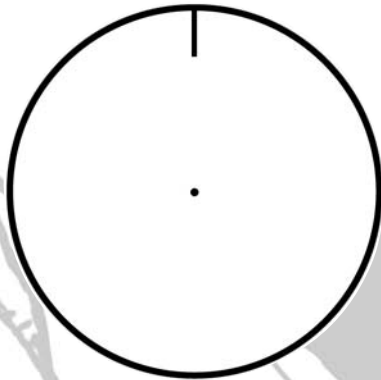
Topsoil



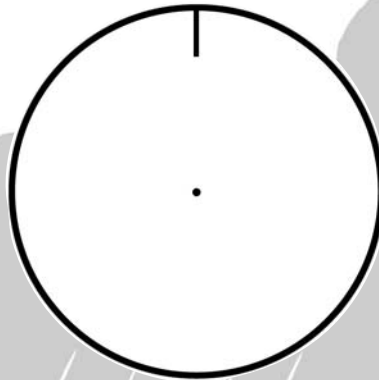
Does This Hold Water?

Cut out the water strips from the first page and tape each into a circle to create circle graphs. Record your data on this page.

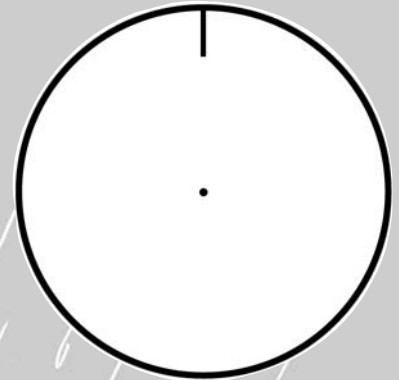
Amount of Water Retained



Sand

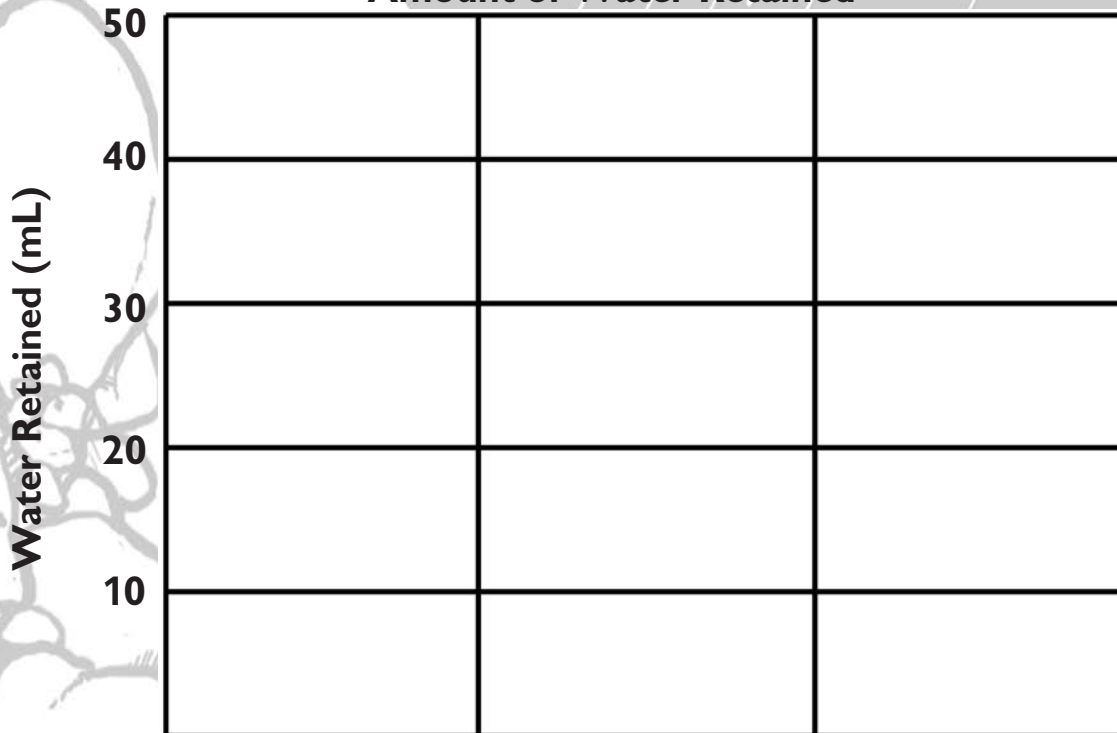


Potting Soil



Topsoil

Amount of Water Retained



Sand

Potting Soil

Topsoil

Type of Material