Earth Systems Science

What Is Soil?

This lesson is taken from an education module developed for Challenger Center's *Journey through the Universe* program. *Journey through the Universe* takes entire communities to the space frontier.

Start the *Journey* at www.challenger.org/journey.

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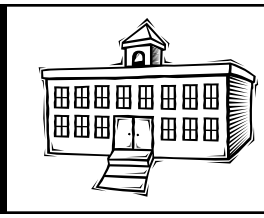
Grade Level

K-12



Family & Home Activity: What Is Soil?

Lesson Summary

This activity is an opportunity for students and their families to pursue a scientific investigation together, to learn more about something that is a part of everyone's life: the soil beneath our feet. Families should feel free to help students with the arithmetic, if necessary, in order to reach the scientific goals. Students and families will collect samples of soil from near the home or around the community, using ordinary kitchen equipment to learn how much water is in the soil, how much of the soil is composed of organic materials, and how much of the soil is composed of rocks & minerals.

At the elementary level (K–4), one sample will be collected and investigated to learn the components of soil. At the middle school level (5–8), three samples will be collected from various places near the home to compare soil composition with observed surface features such as the presence of plants, streams, puddles, etc. At the high school level (9–12), multiple samples will be collected from the community to investigate the composition of soil associated with a variety of surface features. Results collected by students and families can be compiled in class to make a more complete investigation of soil in the community.

Lesson Duration

6 hours

ESSENTIAL QUESTIONS

- What are the different parts of soil?
- How much is there of each part?
- How much does the composition of soil vary?

OBJECTIVES

- (Grades K–12) Identify three components of soil (water, minerals, organic matter).
- (Grades 5–12) Evaluate variations in soil components from soils near home.
- (Grades 9–12) Evaluate variations in soil components from soils around the community and compare soil properties to observable surface features.

CORE STANDARDS

NRC Standards

- K–4 Content Standard A1 (Physical Science): Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers.
- 5–8 Content Standard D1 (Earth and Space Science): Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Soils are often found in layers, with each having a different chemical composition and texture.
- 9–12 Content Standard F3 (Science in Personal and Social Perspectives): The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed.

Science Overview

Soil consists of three basic components: minerals, organic materials, and water. Soil missing any one of these is not likely to support life well. However, different soils have different amounts of each, which affects the amount and the type of plant life that can use the soil. Seaweed and cacti, to name two extreme examples, are plants that require very different proportions of water in the growing medium. Cacti depend upon very dry soil. However, if the water in soil evaporates completely, the soil itself will be left dry and lifeless.

Organic materials are anything made out of molecules that contain carbon atoms. The organic materials in soils mostly come from the decay of growing things at the surface. Leafy plants receive sunlight for photosynthesis, using up carbon dioxide gas from the air to produce organic molecules. When these surface plants die, or shed leaves, these parts decay into the top layers of the soil. Animals, also, consume plants and leave droppings and their own dead bodies on the soil surface. As a result, the layer of soil that contains organic materials forms as a relatively thin sheet of topsoil on top of organic-poor soil, sitting atop bedrock. The organic-rich topsoil can be carried away by erosion if the soil is not bound together by a tightly-woven root network, thereby exposing the organic-poor soil beneath. Physical disturbances to the soil, such as construction work, also can result in the burial or removal of topsoil, leaving organic-poor fill dirt at the surface. Organic-poor soils eventually can develop a new layer of topsoil, but it may take considerable time (decades) and careful nurturing to enrich the soil. The organic-poor soil, which is not tightly bound together by living plant roots since it does not support abundant plant life, may erode away before new topsoil can develop. Soil can be eroded away until only bedrock remains.

The mineral component of soil accounts for most of its mass in most places and is the least biologically active component; this is what composes the organic-poor, or inorganic, portion of soil. Mineral soil is pulverized rock, worn down from the Earth's crust by the action of wind and weather. The single most common mineral in Earth's soil is silicon dioxide (SiO_2) — quartz — but there are many other minerals in the Earth's

crust, and in its soils, as well. While the mineral part may be the least biologically active portion of soil, it is not biologically unimportant. Mineral soil renews the supply of important inorganic (non-carbon-bearing) nutrients for plant growth. It provides structure to support root systems, and it promotes drainage for the benefit of plants adapted to an environment that is not totally water-logged nor totally composed of organic materials. Swamp environments, by contrast, are extremely rich in water and organic materials and poor in mineral soil. Swamps thus support a different sort of plant life than drier, more mineral-rich soils.

So what is your soil like? There is no such thing as a typical soil, nor is there such a thing as "good" or "bad" soil. "Good" and "bad" apply only to the soil's suitability for some purpose, such as farming, the main activity for which humans directly concern ourselves with soil. Every soil is different, and soils can vary dramatically between locations not far apart. This activity is an opportunity for students to find out on their own what soils are like in and around the community, by directly experimenting to learn how much water is in soil samples and how much of the solid soil is mineral compared to organic matter.

TEACHER MATERIALS
ALL GRADE LEVELS
- Several soil samples in resealable containers (to avoid drying out after collection).
- Completed examples of the student worksheet(s) corresponding to the collected soil samples.
- Several magnifying glasses.

GRADES 9–12 ONLY (for in-class follow-up)
- 3 copies of a local community map displayed on a bulletin board.
- Three colors of chart pins, five pins of each color per student.

STUDENT MATERIALS (per student)

ALL GRADE LEVELS
- Shovel, trowel, or large spoon suitable for digging soil samples.
- Magnifying glass.
- Scale, measuring in ounces or grams. Dietary or postal scales are sufficient, or samples can be weighed in class using a balance.
- Kitchen oven.

Lesson Plan

Preparation & Management

- Prepare several (3–5) soil samples to facilitate in-class warm-up. Choose samples that appear different in color and texture. The class may participate in collecting samples from the school grounds.

- Remind/teach students to weigh an empty container and to subtract its weight from the total weight of the container plus sample.

Teaching Tips

- *Local Post Offices usually have a precision scale available to the public, suitable for small weights, that can be used if no scale is available at home. Remind students to always keep their soil within a container while weighing it!*

- *If no scales are available outside of school, this activity can be adapted to allow weighing in class, using a laboratory balance.*

Warm-Up

Discuss with students the difference between dirt and soil. Lead students to the idea that *dirt* is something unpleasant that you clean off the kitchen floor. *Soil*, on the other hand, is a marvelous material that gives us food to eat and clothes to wear. Ask students to contribute ideas for different products that humans depend on that can be directly traced to soil (*Answers: food crops, fiber crops like cotton, meat, wood, brick, etc.*). Ask them if there is anything that we depend on that has NO connection to soil (*Answer: very little, if anything*). What does soil have in it that makes it a producer of all these things? What makes soil more than dirt?

Ask students if all soil is the same, in their experience. Allow them to examine the soil samples that you collected, using all their senses (except taste!) and using the magnifying glasses. Ask students to describe similarities and differences between the samples.

Pre-Assessment

Based on their examination, ask students to predict what materials make up soil. (*Answer: water, organic materials, minerals*). Based on the texture of the soil samples, students should identify water as one component. Lead students to the idea that soil also has organic materials from leaves and plants decomposing in it. Samples that lack organic materials, and examination under the magnifying glass, should lead students to guess that soil also contains ground-up rock (minerals). Create a list on the board of the class' ideas.

The students have now constructed a concept for the composition of soil. Lead the students to propose measurement procedures to determine how much of each component is in a soil sample, as in the Procedure on the next page. (Note that the Procedure is written for the teacher to interpret, and does not use language appropriate for younger grades.)

STUDENT MATERIALS (per student)

GRADES K–4 ONLY

- 1 copy of grade K–4 Home Activity Worksheet.
- 1 sheet graph paper (for in-class follow-up).
- 1 disposable aluminum pie tin or shallow cake pan.
- Art supplies (pencils, crayons, ruler, etc.).

GRADES 5–8 ONLY

- 1 copy of grade 5–8 Home Activity Worksheet, including data tables and pie chart page.
- 1 additional copy of pie chart page (for in-class follow-up)
- 3 disposable aluminum pie tins or shallow cake pans.
- Protractor.
- Art supplies (pencils, crayons, ruler, etc.).

GRADES 9–12 ONLY

- 1 copy of grade 9–12 Home Activity Worksheet.
- 5 copies of grade 9–12 Home Activity Worksheet Sample Report Page
- 1 copy of a local community map.
- 5 disposable aluminum pie tins or shallow cake pans.

ACTIVITY 1: Soil Composition

Procedure

1. Look at the list of possible soil components created by the class during the warm-up.

2. Start with water: ask students to propose a method for determining if water is present in soil, and if so, how much of the weight is water.
   a. Students probably will suggest many methods to remove the water and measure its volume (e.g., by pressing it).
   b. Ask whether the remaining soil will weigh less after removing the water. Can the change in weight be used to determine how much water was removed?
   c. Lead students to the idea of drying the sample to see how much weight it loses. The lost weight is how much water it had.

3. Organic materials: ask students to propose a method to determine whether organic materials are present in soil, and if so, how much of the weight is organic.
   a. Students already have proposed a way to measure water content, by removing it to see how much difference it makes. Can students propose a similar way to remove all the organic material from soil?
   b. A wooden log is made mostly out of organic materials. What happens to a log that is heated to a high temperature?
   c. What is left after a log is completely burned up? Does the ash weigh more than, less than, or the same as the original log? How could you tell?
   d. Measurements first made over 200 years ago showed that ash weighs less than the original log. What happened to the material that was in the log and isn't there anymore? Compare it to the way that a car burns gasoline, which also is made of organic molecules — what comes out of the car's tailpipe that we must never, ever breathe? (*Exhaust gases*.) The same thing happens to a log that is burned.

4. Review what students have just deduced:
   a. A soil sample can be dried, and the weight lost from the original sample will show how much water was in the sample.

b. A sample of anything made of organic molecules can be heated up enough to make the organic molecules burn up into exhaust gases.
c. If there is anything left to weigh after burning up all the organic molecules, what do the students think it is? (*NOT organic materials.*)
d. What can you learn by comparing the weight of what is left over with the starting weight? (*How much of the soil's weight is organic materials.*)

5. Whatever is left after drying a soil sample and burning up all its organic molecules is not organic. This is the mineral part of soil, powdered rock, which can melt, burn, or vaporize, only at MUCH hotter temperatures. It can be weighed and compared to the original weight to learn how much of the soil's weight is from minerals.

6. Ask the students if this makes a set of things they could do to learn how much water, organic matter, and minerals are in soil, by weight?

7. Distribute the Home Activity Worksheets. Tell students that they will go home and ask for the help of their family in doing exactly the experiment that they just figured out. Read through the instructions with the students before they bring it home.

8. Give students a timeline for when the activity should be completed.

9. Students will analyze the results from the Family & Home Activity with the help of their family, using the following strategies:
K-4: Students will determine which component accounts for most of the weight in their sample, which component accounts for the second most, and which accounts for the least.
5-8: Students will create a pie chart for each sample, showing how much of each component was in each sample.
9-12: Students will determine the fraction by weight of each soil component in each sample. Students will evaluate whether their predictions for soil composition based on the observed surface features agree with their results or disagree, and propose arguments to explain disagreements.

Reflection & Discussion

- Review with students the three main parts of soil. (*Water, organic materials, and minerals.*) Compare to students' findings.

- Grades K–4:
  - For each soil component (water, organic, mineral), how many students said it was most of the weight? Second-most? The least part?
  - Have students prepare a page with three bar graphs on it: one for the class vote on the soil component that had most of the weight, one for the component that was second-most, and one for the component that was the least part of the weight. Label the bars in each graph, according to the soil component it represents. Above each bar graph, title it "MOST WEIGHT IN SOIL", "SECOND MOST WEIGHT IN SOIL", and "LEAST WEIGHT IN SOIL". Below each bar graph, make a small drawing that shows which soil component got the most votes for that graph.
  - The worksheet and the page of bar graphs can be graded according to the rubrics that follow.

- Grades 5–8:
  - Come up with a short list of site descriptions that fits most of the sample sites used by the class. There may be more or less than three items on this list. There may be some student sample sites that do not fit any description on the short list.
  - For each site description, ask students to contribute their measured weight of water, organic material, and mineral soil. Add up the results for each soil component to get a total of water weight, organic weight, and mineral weight for that type of site.
  - For each site description, ask students to contribute their observations on the soil itself — texture, feel, color, smell, or anything else they observed. Is there a set of properties in common for sites that fit the surface description?
  - Have students prepare a pie chart for each of the site descriptions. Title each of the pie charts with its description, label the three pieces of the pie chart, and color-code each piece according to the student's preference. Below each pie chart, create a drawing or graphic that depicts a site that fits the description, and indicates the students' observations of the soil itself. Label the pages with an overall title and create a color key for the charts.
  - The worksheet and page of pie charts can be graded according to the rubrics that follow.

- Grades 9–12:
  - Post three maps of the community on a bulletin board. Label one "WATER CONTENT," label one "ORGANIC CONTENT," and label one "MINERAL CONTENT"
  - Ask students to contribute all their measured values for the percentage weight of each component in their samples.
  - Assign a chart pin color for the lowest third, the middle third, and the upper third of measured percentage weight for each soil component.
  - Ask students to place a chart pin on each map for each of their samples, colored according to the assigned scale, at the measurement site of the sample.
  - Are there any patterns in the maps? Any patterns comparing the maps?

Transfer of Knowledge

- K–4: What is the main use for land in your community? Do you think that the nature of the soil that most of the class agreed on has anything to do with how the land is used — or does the way that the land is used affect the kind of soil samples that come from your community?

- 5–8: If you were planning to plant a garden or develop a farm, what kind of soil would you want to have at the place that you would plant? Could you use soil samples and these kinds of methods to decide what is the best place to plant? What would you have to keep in mind besides soil composition in planting a garden?

- 9–12: Environmental protection organizations may use resource maps to locate habitats or to identify environmental damage, based on a selection of samples. People and organizations that wish to use resources also may use resource maps to find places they want to utilize or to avoid. Each group may disagree with the other's resource map or with the interpretation of it. Does your experience with mapping soil properties suggest the extent to which these sorts of resource maps may be trusted or mistrusted?

ASSESSMENT

Student Worksheets (line-by-line and table portions)

4 Points
- All observations are completed as directed.
- Procedures followed correctly and fully.
- Measurements made according to class discussions.
- Interpretations are consistent with the recorded results of the measurements.

3 Points
- Observations are mostly complete.
- Procedures followed correctly, with minor lapses.
- Measurements made according to class discussions.
- Interpretations are consistent with the recorded results of the measurements.

2 Points
- Observations are not complete, but sufficient for some conclusions.
- Errors in procedure, but not enough to invalidate the whole activity.
- Measurements rounded off to insufficient precision.
- Interpretations are consistent with the recorded results of the measurements.

1 Point
- Observations are not complete, but sufficient for some conclusions.
- Errors in procedure, but some portions followed correctly.
- Measurements rounded off to insufficient precision.
- Interpretations are not supported by measurements.

0 Points
- No observations are complete.
- Record of procedure not present or unreadable.
- Measurements made incorrectly or missing.
- Interpretations missing or not supported by whatever work has been done.

ASSESSMENT

K-4 Bar Graphs

4 Points
- All required labels and titles are present.
- All required labels and titles that are present are accurate and complete.
- The graphs accurately represent the results.
- The graphs are clear, legible, and unambiguous.
- The graphic elements are present and are correctly related to the bar graph.

3 Points
- Most of the required labels and titles are present.
- The required labels and titles that are present are accurate and mostly complete.
- The graphs accurately represent the results.
- The graphs are clear, legible, and unambiguous.
- The graphic elements may not all be present, but are correctly related to the bar graph.

2 Points
- Most of the required labels and titles are present.
- The required labels and titles that are present are accurate and mostly complete.
- The graphs correctly represent the results, with minor errors.
- The graphs are sufficiently clear to interpret. Some elements may be ambiguous.
- The graphic elements may not all be present or correctly related to the bar graph.

1 Point
- Few of the required labels and titles are present.
- The required labels and titles that are present may be partially inaccurate and/or are incomplete.
- The graphs represent the results poorly.
- The graphs are not clear enough to interpret easily.
- Few if any of the graphic elements are present or correctly related to the bar graphs.

0 Points
- The required labels and titles are not present.
- The graphs are unrelated to the results or are uninterpretable.
- The graphic elements are missing or unrelated to the bar graphs.

ASSESSMENT

5-8 Pie Charts

4 Points
- All required labels and titles are present.
- All required labels and titles that are present are accurate and complete.
- The charts accurately represent the results.
- The charts are clear, legible, and unambiguous.
- The graphic elements are present and are correctly related to the pie charts.

3 Points
- Most of the required labels and titles are present.
- The required labels and titles that are present are accurate and mostly complete.
- The charts accurately represent the results.
- The charts are clear, legible, and unambiguous.
- The graphic elements may not all be present, but are correctly related to the pie chart.

2 Points
- Most of the required labels and titles are present.
- The required labels and titles that are present are accurate and mostly complete.
- The charts correctly represent the results, with minor errors.
- The charts are sufficiently clear to interpret. Some elements may be ambiguous.
- The graphic elements may not all be present or correctly related to the pie chart.

1 Point
- Few of the required labels and titles are present.
- The required labels and titles that are present may be partially inaccurate and/or are incomplete.
- The charts represent the results poorly.
- The charts are not clear enough to interpret easily.
- Few if any of the graphic elements are present or correctly related to the pie charts.

0 Points
- The required labels and titles are not present.
- The charts are unrelated to the results or are uninterpretable.
- The graphic elements are missing or unrelated to the pie charts.

ASSESSMENT

9–12 Predictions and Results

Note that there is no requirement that predictions be accurate, only that they be supported by reasoning from evidence, and that discrepancies from the measurements be addressed and consistent with all observations.

4 Points

- Argument supporting prediction for soil composition accounts for observations of surface features and inspection of soil.
- Reported result is consistent with the data.
- Interpretation of the results' agreement with or refutation of predictions is consistent with all observations.
- Good use of adjectives to describe results.
- Writing is clear, understandable, and precise.

3 Points

- Argument supporting prediction for soil composition does not address all of the surface features or all of the observations from inspecting the soil.
- Reported result is consistent with the data.
- Interpretation of the results' agreement with or refutation of predictions is consistent with the measurements and most of the other observations.
- Writing is understandable.

2 Points

- Argument supporting prediction for soil composition only a few of the surface features or observations from inspecting the soil.
- Reported result is consistent with the data.
- Interpretation of the results' agreement with or refutation of predictions is consistent with the measurements but addresses the other observations incompletely or not all.
- Writing may not be clear, but is understandable.

1 Point

- Prediction for soil composition is not supported by an argument based on data.
- Reported result is inconsistent with the data.
- Interpretation of the results' agreement with or refutation of predictions is consistent with the reported result but is not otherwise supported by argument based on observations.
- Writing may be difficult to understand.

0 Points

- Prediction for soil composition is not present.
- Reported result is unrelated to the data.
- Interpretation of results is not present.
- Writing is not readable or is off-topic.

HOME ACTIVITY WORKSHEET K-4: WHAT IS SOIL?

Name _____ **Date** _____

Soil is a part of everyone's life. This is a chance to learn more about the soil where you live. You will dig up a sample of soil and learn how much of its weight is from water, how much is from organic materials, and how much is from minerals. You will need to dry the soil sample in a kitchen oven, and then you will need to roast it in the oven. You will need to weigh the soil sample at the start, after drying it, and after roasting it. It's okay to use a calculator or for parents to help with subtracting numbers.

Materials

- Shovel, trowel, or large spoon to dig soil sample.
- Magnifying glass
- Scale, to weigh in ounces or grams (Try using the scale at the Post Office if you don't have a suitable scale at home.)
- Kitchen oven
- Disposable aluminum pie tin or shallow cake pan
- Blank sheet of paper

CAUTION

- Only adults should operate the oven, place objects in the oven, or remove objects from the oven.
- Do not collect soil samples from sites near gas stations or other locations that may spill flammable liquids or that are obviously polluted. The samples will be heated in your kitchen oven.
- DO NOT use glass or nonstick-coated pans. Glass may shatter, and nonstick coatings will be destroyed by very high heat.

Procedure

1) Weigh an empty pie pan, in ounces or grams:___
2) Collect a sample of soil from near your home, weighing about 10 ounces or 283 grams. Remove any obvious living things (earthworms, insects, etc.).
3) Examine the soil using a magnifying glass. On a blank paper, draw a picture of what you see.
4) Feel the soil and describe it — Is it dark-colored or light-colored? Is it moist or dry? Is it clumpy or smooth? _____
5) Put the soil sample in the pie pan. Break up any clumps and loosely spread the soil over the bottom of the pan. Weigh the pie pan and soil together:_____

HOME ACTIVITY WORKSHEET K-4: WHAT IS SOIL?

_____

6) Subtract the weight of the pie pan (Step 1) from the weight of the pan and soil sample together. This is the starting weight of the soil sample: _____

7) Dry the soil sample by baking it in the oven for two hours at 225˚F (107˚C). Allow it to cool after drying.

8) Feel the soil and describe it — Is it dark-colored or light-colored? Is it moist or dry? Is it clumpy or smooth? _____

9) Weigh the pie pan and dry soil together:_____
_____

10) Subtract the weight of the pie pan-plus-dry soil from the weight of the pie pan-plus-soil in Step 5. This is the weight of water that the drying step removed from the soil: _____

11) Roast the soil sample to remove all the organic materials from it. If you have a self-cleaning oven, just run the sample through a self-cleaning cycle. If you don't have a self-cleaning oven, roast the sample at the highest temperature for two hours, then let it cool for one hour before opening the oven.

12) Feel the soil and describe it — Is it dark-colored or light-colored? Is it moist or dry? Is it clumpy or smooth? _____

13) Weigh the pie pan and roasted soil together: _____

14) Subtract the weight of the pie pan-plus-roasted soil from the weight of the pie pan-plus-dry soil from Step 9. This is the weight of organic material that the roasting step burned out of the soil: _____

15) Subtract the weight of the pie pan (Step 1) from the weight of the pie pan-plus-roasted soil. This is the weight of the mineral part of the soil:_____
_____

16) Copy down the weights for the three parts of the soil and mark which one is most of the weight of the soil, which is second ~~most~~, and which is the least:

a) water (Step 10), weight = _____ most 2nd most least

HOME ACTIVITY WORKSHEET 5-8: WHAT IS SOIL?

Name _____ **Date** _____

Soil is a part of everyone's life. This is a chance to learn more about the soil where you live. You will dig up three samples of soil and learn how much of the weight in each is from water, how much is from organic materials, and how much is from minerals. You will need to dry the soil samples in a kitchen oven, and then you will need to roast them in the oven. You will need to weigh each soil sample at the start, after drying it, and after roasting it. It's okay to use a calculator or for parents to help with subtracting numbers.

Materials

- Shovel, trowel, or large spoon to dig soil sample
- Magnifying glass
- Scale, to weigh in ounces or grams (Try using the scale at the Post Office if you don't have a suitable scale at home.)
- Kitchen oven
- 3 Disposable aluminum pie tins or shallow cake pans
- Protractor

CAUTION

- Adults should strictly supervise use of the oven.
- Do not collect soil samples from sites near gas stations or other locations that may spill flammable liquids or that are obviously polluted. The samples will be heated in your kitchen oven.
- DO NOT use glass or nonstick-coated pans. Glass may shatter, and nonstick coatings will be destroyed by very high heat.

Procedure

1) Weigh the empty pie pans, in ounces or grams, and record the weights in the data table. Mark the pans by bending up the edge of the pan in one place for Sample 1, in two places for Sample 2, and in three places for Sample 3. (You will not be able to keep labels on the pie pans or mark them with a marker because the label will burn off in the oven.)

2) Collect three samples of soil from near your home, weighing about 10 ounces or 283 grams each. Remove any obvious living things (earthworms, insects, etc.). Record a brief description of surface features at the sample site on the data table.

3) Feel the soil and describe it — Is it dark-colored or light-colored? Is it moist or dry? Is it clumpy or smooth? Examine the soil using a magnifying glass. Write the description in the data table and sketch what you see under the magnifying glass.

4) Put the soil samples in the pie pans. Break up any clumps and loosely spread the soil over the bottom of the pan. Weigh the pie pans and soil together and record the weights in the data table.

HOME ACTIVITY WORKSHEET 5-8: WHAT IS SOIL?

5) Dry the soil samples by baking them in the oven for two hours at 225˚F (107˚ßC). Allow them to cool after drying.

6) Feel the soil and describe it — Is it dark-colored or light-colored? Is it moist or dry? Is it clumpy or smooth? Write the description in the data table.

7) Weigh the pie pans and dry soil together and record the weights in the data table.

8) Roast the soil samples to remove all the organic materials from the soil. If you have a self-cleaning oven, just run the samples through a self-cleaning cycle. If you don't have a self-cleaning oven, roast the samples at the highest temperature for two hours, then let them cool for one hour before opening the oven.

9) Feel the soil and describe it — Is it dark-colored or light-colored? Is it moist or dry? Is it clumpy or smooth? Write the description in the data table.

10) Weigh the pie pans and roasted soil together and record the weights in the data table.

11) Complete the entries in the data table:

a) Determine the initial weight of the soil samples by subtracting the weight of the pan from the initial weight of the pan-plus-soil.

b) Determine the initial weight of water in the samples by subtracting the weight of the pan-plus-dry soil from the initial weight of the pan plus soil.

c) Determine the weight of organic material in the samples by subtracting the weight of the pan-plus-roasted soil from the weight of the pan-plus-dry soil.

d) Determine the weight of the minerals in the samples by subtracting the weight of the empty pan from the weight of the pan-plus-roasted soil.

e) Determine the percentage weight of each component in each sample by dividing the weight of each component by the initial weight of that sample and multiplying by 100.

12) Complete the pie chart page. Title each chart, taking the title from the description of the sample site; fill in the chart according to the percentage of each soil component in the sample and label the pie slices; complete the color key for all three pie charts; and under each pie chart, fill in the square with a drawing of the sample site or a graphic showing the important things about that site. See if you can include something representing the description of the soil sample.

HOME ACTIVITY WORKSHEET 5-8: DATA TABLES

Sample 1	Sample 2	Sample 3
Weight of pan:	Weight of pan:	Weight of pan: _
Describe sample site:	Describe sample site:	Describe sample site:
Describe soil, sketch	Describe soil, sketch	Describe soil, sketch
Wt. pan + soil:	Wt. pan + soil:	Wt. pan + soil: _
Describe soil after drying:	Describe soil after drying:	Describe soil after drying:
Wt. pan + dry soil:	Wt. pan + dry soil:	Wt. pan + dry soil:
Describe soil after roasting:	Describe soil after roasting:	Describe soil after roasting:
Wt. pan + roasted soil:	Wt. pan + roasted soil:	Wt. pan + roasted soil: _____
Weight of soil components: weight % initial 100% water organics mineral	Weight of soil components: weight % initial 100% water organics mineral	Weight of soil components: weight % initial 100% water organics mineral

Pie Chart Color Key water, weight %

HOME ACTIVITY WORKSHEET 5-8: PIE CHARTS

organics, weight %

minerals, weight %

Drawing of Sample Site:	Drawing of Sample Site:	Drawing of Sample Site:

HOME ACTIVITY WORKSHEET 9-12: WHAT IS SOIL?

Name _____ **Date** _____

Soil is a part of everyone's life. This is a chance to learn more about the soil where you live. You will dig up five samples of soil from places around your community and learn how much of the weight in each is from water, how much is from organic materials, and how much is from minerals. Select the samples from sites as different as possible from one another, and record on a map the location from which each sample was obtained. You will need to dry the soil samples in a kitchen oven, and then you will need to roast them in the oven. You will need to weigh each soil sample at the start, after drying it, and after roasting it.

Materials

- Shovel, trowel, or large spoon to dig soil sample
- Magnifying glass
- Scale, to weigh in ounces or grams (Try using the scale at the Post Office if you don't have a suitable scale at home.)
- Kitchen oven
- 5 disposable aluminum pie tins or shallow cake pans
- Map of your local community

CAUTION

- Be careful using the oven — it will be heated to its maximum temperature for two hours.
- Do not collect soil samples from sites near gas stations or other locations that may spill flammable liquids or that are obviously polluted. Such samples may be hazardous when heated in your kitchen oven.
- DO NOT use glass or nonstick-coated pans. Glass may shatter, and nonstick coatings will be destroyed by very high heat.

Procedure

1) You will need one copy of the Sample Report page for each soil sample that you collect (minimum of five).

2) Weigh the empty pie pans, in ounces or grams, and record the weights on the Sample Reports. Mark the pans by bending up the edge of the pan in one place for Sample 1, in two places for Sample 2, and so on. (You will not be able to keep labels on the pie pans or mark them with a marker because the label will burn off in the oven.)

3) Collect five (or more) soil samples, weighing about 10 ounces or 283 grams each. Select each collection site to be as different from the others as possible, at various locations around your community. Write a description on the Sample Report of surface features at the collection site. Record the location of the sampled sites on the community map.

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4) Clean the soil samples by removing any obvious living things (earthworms, insects, etc.).

5) Feel the soil samples and describe them — Is the soil dark-colored or light-colored? Is it moist or dry? Is it clumpy or smooth? Examine the soil using a magnifying glass. Write the description in the Sample Report and sketch what you see under the magnifying glass.

6) This experiment will result in an estimate of how much water, organic materials, and minerals will be in each soil sample, by percentage of the total weight. Record your predictions on the Sample Report for roughly how much of each you anticipate, and how you expect that each sample you collected will compare to the other samples. Include a brief argument supporting your prediction, based on your preliminary observations of the sample collection sites and the soil samples themselves. Don't worry if you feel that you don't know enough yet to make an accurate prediction — just make the best prediction you can, based on what you know and think before you make the measurements. New science and new knowledge come from discovering that our best predictions are inaccurate.

7) Put the soil samples in the pie pans. Break up any clumps and loosely spread the soil over the bottom of the pan. Weigh the pie pans and soil together and record the weights on the Sample Reports.

8) Dry the soil samples by baking them in the oven for two hours at 225°F (107°C). Allow them to cool after drying.

9) Feel the soil and describe it — Is it dark-colored or light-colored? Is it moist or dry? Is it clumpy or smooth? Write the description on the Sample Report.

10) Weigh the pie pans and dry soil together and record the weights on the Sample Report.

11) Roast the soil samples to remove all the organic materials from the soil. If you have a self-cleaning oven, just run the samples through a self-cleaning cycle. If you don't have a self-cleaning oven, roast the samples at the highest temperature for two hours, then let them cool for one hour before opening the oven.

12) Feel the soil and describe it — Is it dark-colored or light-colored? Is it moist or dry? Is it clumpy or smooth? Write the description on the Sample Report.

13) Weigh the pie pans and roasted soil together and record the weights on the Sample Report.

14) Complete the entries on the Sample Report.

    a) Determine the initial weight of the soil samples by subtracting the weight of the pan from the initial weight of the pan-plus-soil.

    b) Determine the initial weight of water in the samples by subtracting the weight of the pan-plus-dry soil from the initial weight of the pan plus soil.

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c) Determine the weight of organic material in the samples by subtracting the weight of the pan-plus-roasted soil from the weight of the pan-plus-dry soil.

d) Determine the weight of the minerals in the samples by subtracting the weight of the empty pan from the weight of the pan-plus-roasted soil.

e) Determine the percentage weight of each component in each sample.

15) Compare the results for each sample to your predictions. To what extent do the results agree with your predictions? Disagree? How can you refine your predictions to agree with the measured results and all the other observations for that sample? Can you suggest any further measurements needed (not necessarily possible for you to make) to test your new predictions?

HOME ACTIVITY WORKSHEET 9-12:SAMPLE REPORT

Sample #	Prediction for Results:
Weight of pan: _____	
Describe sample site:	
Describe soil, sketch	Support prediction based on observations of surface and soil:
Wt. pan + soil: _____	
Describe soil after drying:	
Wt. pan + dry soil: ___	Conclusions: do the results agree with your predictions or disagree? Can you refine your predictions?
Describe soil after roasting:	
Wt. pan + roasted soil: _____	
Weight of soil components: weight _____ %____ initial _____100% water organics mineral _____ ____	

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