Air in Soil
Task Information

Subject: Earth Science

Content:

- NYS Syllabus (1970 ed.) Topic VIII A-1,3 Porosity
- NYS Pro. Mod. Syllabus (1993 ed.) Unit 7 A3 - Where Does Water Come From?
- MST Framework (Draft) Standard 4 - Many of the phenomena that we observe on Earth involve interactions of air, water, and land components.
- Middle Level Science Block D II A 1 e.1 - Soils

Format: Manipulative

Purpose To determine the percent of air space in soil.

Skills:

Primary: Measuring, recording data, applying math, designing an experiment

Secondary: Generalizing/inferring, observing

Time 25-30 minutes

Materials:

Per Student

- 2 metric cups (at least 250 mL)
- water
- spoon
- dry topsoil sample - 200+ ml
- washing bottle
- paper towels
- waste container

Preparation:

1) If potting soil is to be used, open the bag and spread out soil for a few days to be certain it is completely dry. (This may be a good idea with most soils.)
2) Check the dry soil to make sure it will allow water to fill air space and not have particles buoy upward. Sandy soils or rich loam work best. Soils which work good for activity may be spread out and dried for reuse.
3) Graduated cups should be at least in 10 ml increments. Strips of transparent divisions may be taped on the side of beaker or cup to provide more precise readings.
4) A large dump bucket will be needed to empty student waste containers if stations are to be used several times.

Safety: N/A

Extensions/Modifications:

Different soils may be used to check variations in porosity.

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Air in Soil 1

Task: At this station, you will determine the amount of air space present in a soil sample.

Materials:

- 2 metric cups (at least 250 mL)
- paper towels
- dry top soil sample
- waste container
- water
- spoon
- washing bottle

Background:

Soils in the natural environment are a mixture of mineral particles, plant remains, air, water, and other materials. Because mineral grains and organic materials are not always regularly shaped, the particles in soil have spaces between them. These air spaces may fill with air and/or water.

Directions:

1. Pour 100 mL of water into one of the metric cups.
2. Place 100 mL of soil into the other metric cup.
3. Carefully pour the water into the cup containing the soil, observing closely as you do so..
4. Stir gently until bubbles stop coming from the soil.
5. Measure and record the volume of the water and soil mixture and complete the calculations on the data table.

	Volume
Volume of Water	100 mL
Volume of Dry Soil	100 mL
Total volume of Water and Soil	200 mL
Actual Volume of Water and Soil mixture	mL
Difference Between Actual and Total	mL

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Air and Soil 1
Answer Sheet

6. Calculate the percentage of pore space filled with air in your soil sample. Show your work in the space below.

Percent (%) = $\frac{\text{difference between total and mixture volume}}{\text{actual volume of the soil}} \times 100$

Answer_____

7. Based on your observations in this task, why might soil with a lot of air or pore space in it be better for plant growth than soil with little pore space? Use complete sentences in your explanation.

_____

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_____

8. In the space below, design a controlled experiment you could use to determine the amount of water in a soil sample taken from your backyard.

_____

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9. Empty the soil and water mixture into the waste container and rinse the metric soil cup.

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April 30, 1996

Air in Soil 1 - Scoring Rubric

Maximum score - 12 points

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1. Data Table — 2 points total

Standard: The student will determine the actual volume of soil and water and record it correctly on the data table. The student will also calculate and record the difference between the total and the actual values.

Criteria:

A. correct recording of the actual volume of air and soil mixture — **1 point**
Allowable variation +/- 10% of teacher's determination.

B. correct recording of the difference between the student's total and actual values. See Comment 1. — **1 point**

Comment 1: Students should be given points based on their data even if it was incorrect for actual volume.

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2. Percentage of Air — 2 points total

Standard: The student will calculate the percentage of air in the soil based on their data.

Criteria:

A. Substitution of values correct. — **1 point**

B. Calculations correct based on the values substituted. — **1 point**

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3. Why Soil with Pore Space is Good — 2 points total

Standard: The student will write a logical statement that relates pore space to water storage and availability for plant usage.

Criteria:

- A logical and reasonable explanation using complete sentences — **2 points**
- Logical and reasonable answer, but not in complete sentences — **1 point**

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4. Experimental Plan — 6 points total

Standard: The student will design a controlled experiment to determine the amount of water in soil samples. The design will included the following ideas:

- a statement or question for a problem
- formulated hypothesis
- list of materials
- a specific procedure to collect data
- identify variables
- a way to present, analyze, and report data

Criteria:

- for **EACH** of the six ideas — **1 point each**
- give no points for ideas that are omitted or incorrect

Highest possible score - 12 points

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Student ID _____ **Scoring Form - Air in Soil 1**

Male / Female (circle one)

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

1. Data table							
A. actual volume of soil	0	1					
B. difference between actual and total	0	1					
2. Percentage of air							
A. substitution	0	1					
B. calculations	0	1					
3. Why soil with air is good	0	1	2				
4. Experimental plan	0	1	2	3	4	5	6

Total Score _____

(Total possible score - 12 points)

Student ID _____ **Scoring Form - Air in Soil 1**

Male / Female (circle one)

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

1. Data table							
A. actual volume of soil	0	1					
B. difference between actual and total	0	1					
2. Percentage of air							
A. substitution	0	1					
B. calculations	0	1					
3. Why soil with air is good	0	1	2				
4. Experimental plan	0	1	2	3	4	5	6

Total Score _____

(Total possible score - 12 points)

Student ID ES-AS-1 **Scoring Form - Air in Soil 1**

Male / Female (circle one)

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

1. Data table							
A. actual volume of soil	0	(1)					
B. difference between actual and total	0	(1)					
2. Percentage of air							
A. substitution	0	(1)					
B. calculations	0	(1)					
3. Why soil with air is good	0	1	(2)				
4. Experimental plan	0	1	2	3	4	(5)	6

Total Score 11

(Total possible score - 12 points)

Student ID _____ **Scoring Form - Air in Soil 1**

Male / Female (circle one)

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

1. Data table							
A. actual volume of soil	0	1					
B. difference between actual and total	0	1					
2. Percentage of air							
A. substitution	0	1					
B. calculations	0	1					
3. Why soil with air is good	0	1	2				
4. Experimental plan	0	1	2	3	4	(5)	6

Total Score _____

(Total possible score - 12 points)

ES-AS-1

Air in Soil 1

Task: At this station, you will determine the amount of air space present in a soil sample.

Materials:

- 2 metric cups (at least 250mL)
- paper towels
- top soil sample
- waste container
- water
- spoon
- washing bottle

Background:

Soils in the natural environment are a mixture of mineral particles, plant remains, air, water, and other materials. Because mineral grains and organic materials are not always regularly shaped, the particles in soil have spaces between them. These pore spaces may fill with air and/or water.

Directions:

1. Pour 100 mL of water into one of the metric cups.
2. Place 100 mL of soil into the other metric cup.
3. Carefully pour the water into the cup containing the soil, observing closely as you do so..
4. Stir gently until bubbles stop coming from the soil.
5. Measure and record the volume of the water and soil mixture and complete the calculations on the data table.

	Volume
Volume of Water	100 mL
Volume of Dry Soil	100 mL
Total volume of Water and Soil	200 mL
Actual Volume of Water and Soil mixture	160 mL
Difference Between Actual and Total	40 mL

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Air and Soil 1
Answer Sheet

6. Calculate the percentage of pore space filled with air in your soil sample. Show your work in the space below.

Percent (%) = difference between total and mixture volume x 100
actual volume of the soil

$$\% = \frac{40 \times 100}{100}$$

$$\% = \frac{40}{1} \times 10$$

Answer 40%

7. Based on your observations in this task, why might soil with a lot of air or pore space in it be better for plant growth than soil with little pore space? Use complete sentences in your explanation.

Soil w/ a lot of air will have plants grow in it better than soil with little air because plants need air to grow.

8. In the space below, design a controlled experiment you could use to determine the amount of water in a soil sample taken from your backyard.

One way we could find out how much water is in the soil in my backyard is to collect 100 mL of soil in a metric cup and weigh the soil. You could then spread the soil out to let it completely dry. When it is dry, weigh it again to see how many grams of water it lost. The difference between the weight of the soil before drying and after would tell you the weight of the water that was there. Since one gram of water is one mL. Then you could figure the % of water in the soil.

9. Empty the soil and water mixture into the waste container and rinse the metric soil cup.

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Student ID ES-AS-2 **Scoring Form - Air in Soil 1**

Male / Female (circle one)

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

1. Data table							
A. actual volume of soil	(0)	1					
B. difference between actual and total	0	(1)					
2. Percentage of air							
A. substitution	0	(1)					
B. calculations	0	(1)					
3. Why soil with air is good	0	1	(2)				
4. Experimental plan	0	1	(2)	3	4	5	6

Total Score 7

(Total possible score - 12 points)

Student ID _____ **Scoring Form - Air in Soil 1**

Male / Female (circle one)

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

1. Data table							
A. actual volume of soil	0	1					
B. difference between actual and total	0	1					
2. Percentage of air							
A. substitution	0	1					
B. calculations	0	1					
3. Why soil with air is good	0	1	2				
4. Experimental plan	0	1	2	3	4	5	6

Total Score _____

(Total possible score - 12 points)

ES-AS-1

Air in Soil 1

Task: At this station, you will determine the amount of air space present in a soil sample.

Materials:

- 2 metric cups (at least 250mL)
- paper towels
- top soil sample
- waste container
- water
- spoon
- washing bottle

+7/12

Background:

Soils in the natural environment are a mixture of mineral particles, plant remains, air, water, and other materials. Because mineral grains and organic materials are not always regularly shaped, the particles in soil have spaces between them. These pore spaces may fill with air and/or water.

Directions:

1. Pour 100 mL of water into one of the metric cups.
2. Place 100 mL of soil into the other metric cup.
3. Carefully pour the water into the cup containing the soil, observing closely as you do so..
4. Stir gently until bubbles stop coming from the soil.
5. Measure and record the volume of the water and soil mixture and complete the calculations on the data table.

	Volume
Volume of Water	100 mL
Volume of Dry Soil	100 mL
Total volume of Water and Soil	200 mL
Actual Volume of Water and Soil mixture	165 mL
Difference Between Actual and Total	35 mL

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Air and Soil 1
Answer Sheet

6. Calculate the percentage of pore space filled with air in your soil sample. Show your work in the space below.

Percent (%) = difference between total and mixture volume x 100
actual volume of the soil

$$\frac{35 \times 100}{100} = \frac{3500}{100} \quad 35\%$$

Answer 35 %

7. Based on your observations in this task, why might soil with a lot of air or pore space in it be better for plant growth than soil with little pore space? Use complete sentences in your explanation.

The Plant would be able to get its roots into the soil a lot easier if there are air spaces.

8. In the space below, design a controlled experiment you could use to determine the amount of water in a soil sample taken from your backyard.

1. Get 2 cups of 100ml of soil
2. Put one off to the side, set the other one up under a sun lamp provided by your Teacher.
3. After 30 minutes take the soil and remeasure it.
4. Use % = difference between total and actual volume of soil x 100 to get % of water in soil.

9. Empty the soil and water mixture into the waste container and rinse the metric soil cup.

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Student ID ES-AS-3 **Scoring Form - Air in Soil 1**

Male / Female (circle one)

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

1. Data table							
A. actual volume of soil	(0)	1					
B. difference between actual and total	0	(1)					
2. Percentage of air							
A. substitution	0	(1)					
B. calculations	(0)	1					
3. Why soil with air is good	(0)	1	2				
4. Experimental plan	0	1	(2)	3	4	5	6

Total Score 4

(Total possible score - 12 points)

Student ID _____ **Scoring Form - Air in Soil 1**

Male / Female (circle one)

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

1. Data table							
A. actual volume of soil	0	1					
B. difference between actual and total	0	1					
2. Percentage of air							
A. substitution	0	1					
B. calculations	0	1					
3. Why soil with air is good	0	1	2				
4. Experimental plan	0	1	2	3	4	5	6

Total Score _____

(Total possible score - 12 points)

ES-AS-3

Air in Soil 1

Task: At this station, you will determine the amount of air space present in a soil sample.

Materials:

- 2 metric cups (at least 250mL)
- paper towels
- top soil sample
- waste container
- water
- spoon
- washing bottle

+4/12

Background:

Soils in the natural environment are a mixture of mineral particles, plant remains, air, water, and other materials. Because mineral grains and organic materials are not always regularly shaped, the particles in soil have spaces between them. These pore spaces may fill with air and/or water.

Directions:

1. Pour 100 mL of water into one of the metric cups.
2. Place 100 mL of soil into the other metric cup.
3. Carefully pour the water into the cup containing the soil, observing closely as you do so..
4. Stir gently until bubbles stop coming from the soil.
5. Measure and record the volume of the water and soil mixture and complete the calculations on the data table.

	Volume
Volume of Water	100 mL
Volume of Dry Soil	100 mL
Total volume of Water and Soil	200 mL
Actual Volume of Water and Soil mixture	170 mL
Difference Between Actual and Total	30 mL

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Air and Soil 1
Answer Sheet

6. Calculate the percentage of pore space filled with air in your soil sample. Show your work in the space below.

Percent (%) = difference between total and mixture volume x 100
actual volume of the soil

$$\frac{3D \times 10\Delta}{100} = \frac{300}{100}$$

Answer 3 %

7. Based on your observations in this task, why might soil with a lot of air or pore space in it be better for plant growth than soil with little pore space? Use complete sentences in your explanation.

Soil with more air in it provides more carbon dioxide for the plant roots.

8. In the space below, design a controlled experiment you could use to determine the amount of water in a soil sample taken from your backyard.

Take 100 mL of soil and allow it to dry out. Measure the new volume, and use the difference to calculate the percent of water.

9. Empty the soil and water mixture into the waste container and rinse the metric soil cup.

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