

The trees in my neighbourhood

Module 4 Each tree has its own soil requirements

Summary of module 4

Students become familiar with the types of soil texture and relate them to the tree's needs. In the first activity, they perform a tactile test to identify soil texture. In the second activity, they use measurements to verify their observations. Finally, they link each soil texture to the tree species that can adapt to it. They recommend a species to be planted, as a function of the texture of the soil near the school (in Module 5 – optional).

Cross-curricular competency

- CCC1 - Use information

Subject area competencies

- SAC1 - Seek answers or solutions to scientific or technological problems: define a problem, choose an investigation or design scenario, carry out the procedure, conduct an experiment, analyze the results or solution
- SAC2 - Make the most of knowledge of science and technology: understand how technical objects work, understand natural phenomena
- SAC3 - Communicate in the languages used in science and technology: participate in exchanging scientific and technological information, divulge scientific or technological knowledge or results, interpret and produce scientific and technological messages

Objectives

- Understand the relationship between the characteristics of soil and the needs of the tree
- Become familiar with the types of soil texture

Contents

- Diversity of life: habitat, physical and behavioral adaptation
- Life-sustaining processes: photosynthesis and respiration
- General characteristics of the Earth: water
- Geological and geophysical phenomena: water cycle

Classroom organization

- As a group and in teams of 4 to 6 students
- Duration: two class sessions, of 45 and 60 minutes

Soil requirements

- One 2 kg (approx.) bag of sand, for ex. cement sand
- One 2 kg (approx.) bag of clay
- One batch of soil (approx. 3.5 kg) from the location intended for tree planting
- Soil samples of 500 g brought in by students who wish to analyze the soil texture of their yard or neighborhood

Sequence of activities for Module 4

Activity 1: *Getting your hands dirty* – 45 minutes in class – as a group and in teams of 4 to 6 students

Students learn to make a qualitative distinction between different soil textures, by two tactile tests (handful test, ribbon test). One of the soil samples to be tested is from the location intended for tree planting. The other samples are brought by students (optional). Students fill out the **Experiment 1 worksheet**. They become initiated to the research protocol to follow for Activity 2.

Activity 2: *I choose a tree* – 60 minutes in class – as a group and in teams of 4 to 6 students

Students learn to make a quantitative distinction between different soil textures. After measuring layers of sand, clay and silt by decantation, they time how long it takes each type of soil to drain. They use their conclusions and a chart to identify the tree species adapted to their soil. Finally, they decide together which tree species to plant in the location they have chosen (optional).



Summary

Students learn to make a qualitative distinction between different soil textures, by two tactile tests (handful test, ribbon test). One of the soil samples to be tested is from the location intended for tree planting. The other samples are brought by students (optional). Students fill out the **Experiment 1 worksheet**. They become initiated to the research protocol to follow for Activity 2.

Classroom organization

45 minutes in class – as a group and in teams of 4 to 6 students

Preparation – 30 minutes

You will need 3 batches of soil of different textures (A, B and C) for these 2 activities.

- First define the number of teams, in order to prepare the correct number of soil samples.
- Each team requires 2 samples from each batch, each approximately 250 g (1 cup).

To constitute the 3 types of soil:

1. Take one 2 kg (approx.) bag each of clay and sand.
2. Collect a batch of soil of 3.5 kg (approx.) from the location intended for tree planting (from a depth of approximately 30 cm).
3. Batch A (texture to be identified): this is the soil from the location intended for tree planting.
4. Batch B (sandy soil): prepare a mixture according to these proportions: approximately 2/3 sand and 1/3 soil from batch A.
5. Batch C (clay soil): prepare a mixture according to these proportions: approximately 1/2 clay and 1/2 soil from batch A.
6. Batch D (optional – texture to be identified): for each team, prepare a soil sample of 500 g (taken from a depth of approximately 30 cm) from soil in students' yards or neighborhood.

N.B. You may have to sift batches A and D to remove rocks, stones or gravel.

Material required for each team

Four 500 ml bowls or beakers

One 250 g (1 cup) sample of each type of soil (A,B,C)

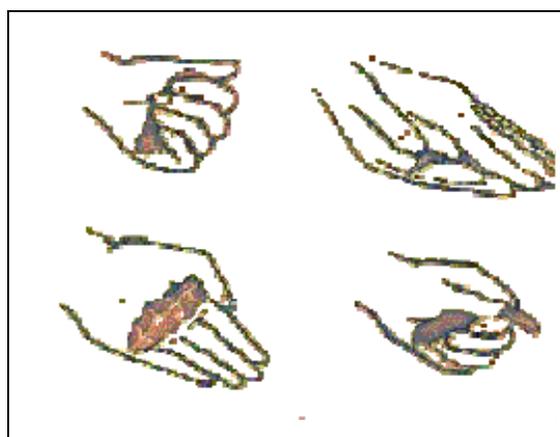
Sample D (optional)

Worksheet title	Contents	Quantity/User
Concepts	Soil texture	1 teacher
Answer key 1	Answers to Experiment 1 worksheet	1 teacher

Experiment 1	Protocol for the qualitative test	1 per student
Experiment 2	Protocol for the quantitative test	1 per student

Step-by-step procedures

- Remind students that the tree has a relationship with its environment, and review the concepts covered in previous modules if they were presented to the class. Explain that the soil constitutes an important component of the tree's environment and that its type determines the species that can be planted in it. Review concepts related to soil and texture (**Concept worksheet**).
- Distribute the **Experiment 1 worksheet** and explain the tactile test protocol.
- Present the tree types of soil and explain how to recognize them. Explain the procedure for the two tests (handful of soil and ribbon), using the image below.
 - **Principle of the handful of earth test:**
determine whether a handful of earth can be compressed easily without breaking it into clumps, and whether finger marks remain imprinted in the soil.
 - **Principle of the soil ribbon test:**
determine whether one can make a ribbon and whether it will break or crack easily.



- Allow the students to experiment in teams, and fill out the **Experiment 1 worksheet**.
- Start a discussion about the results (as a group), and make corrections as necessary.
- Distribute the **Experiment 2 worksheet** and complete steps 1, 2 and 3 of the experiment protocol in preparation for **Activity 2** (allow a minimum of 24 h for soil to settle). Summarize the concepts covered during the activity.

Summary

Students learn to make a quantitative distinction between different soil textures. After measuring layers of sand, clay and silt by decantation, they time how long it takes each type of soil to drain. They use their conclusions and a chart to identify the tree species adapted to their soil. Finally, they decide together which tree species to plant in the location they have chosen (optional).

Classroom organization

60 minutes in class – as a group and in teams of 4 to 6 students

Material required for each team (first test)

One 250 g sample of each type of soil (A, B, C)
Sample(s) D (optional)
Four 500 ml (approx.) jars (including cover)
A teaspoon
Table salt
1 ruler
1 stopwatch (or a watch with a second hand)

Worksheet title	Contents	Quantity/User
Concepts	Soil texture	1 teacher
Answer key 2	Answers to Experiment 2 worksheet	1 teacher
Experiment 2	Protocol for the quantitative test	1 per student

Step-by-step procedures

- Review soil texture concepts and summarize what was accomplished in Activity 1.
- Conduct the experiment. Fill out the rest of **Experiment 2 worksheet** while conducting the experiment.
- Compile the results.

Soil texture

The soil is fundamental for tree growth. Trees extract water and mineral salts from the earth to meet their nutritional requirements. The soil also anchors their roots, and constitutes the environment in which its seeds germinate. In order to plant the right tree in the right location, a few pedological concepts (pedology is the science of soil) are very useful!

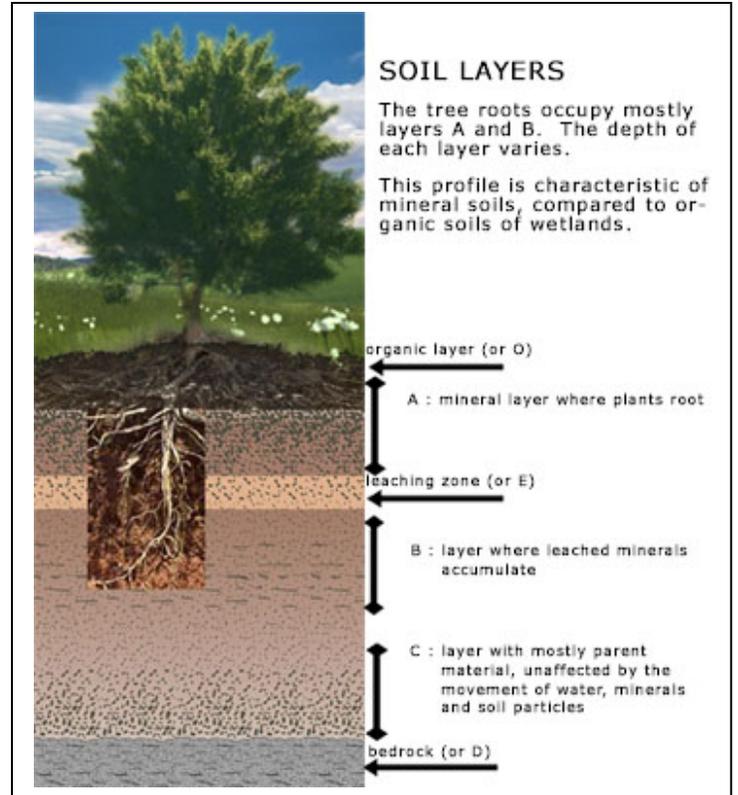
The soil is composed of several layers (or horizons).

Plants primarily take root in horizon A.

Superficial organic debris (humus) makes up horizon O.

Horizon B contains more mineral matter but is less accessible to plants.

Horizon C contains debris from the parent rock, which itself composes horizon D.



One of the key characteristics of soil, one that determines which tree species will grow in it, is texture. **Texture** is the *proportion* of each of three large particles of which soil is composed: sand, silt and clay.

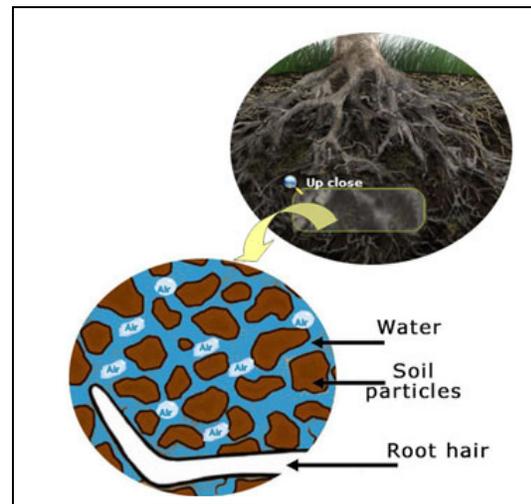
Grains of sand are the largest particles, and clay constitutes the smallest. Silt grains are of an intermediary size.

Soil also contains larger particles (gravel, rock), but they are not considered when determining texture.

The interstices between particles are filled by air and water.

Soil texture should not be confused with its **structure**.

The latter depends on the **size** of the different particles that make up the soil.



See also :
[Nutrient absorption](http://www.aucoeurdelarbre.ca/en/the-living-tree/elements-nutritives-absorption.php)

<http://www.aucoeurdelarbre.ca/en/the-living-tree/elements-nutritives-absorption.php>

Particles of sand make soil texture more granular and therefore crumbly. Smaller particles like clay give soil a sticky texture. This is what makes it possible to roll the soil into a ribbon.

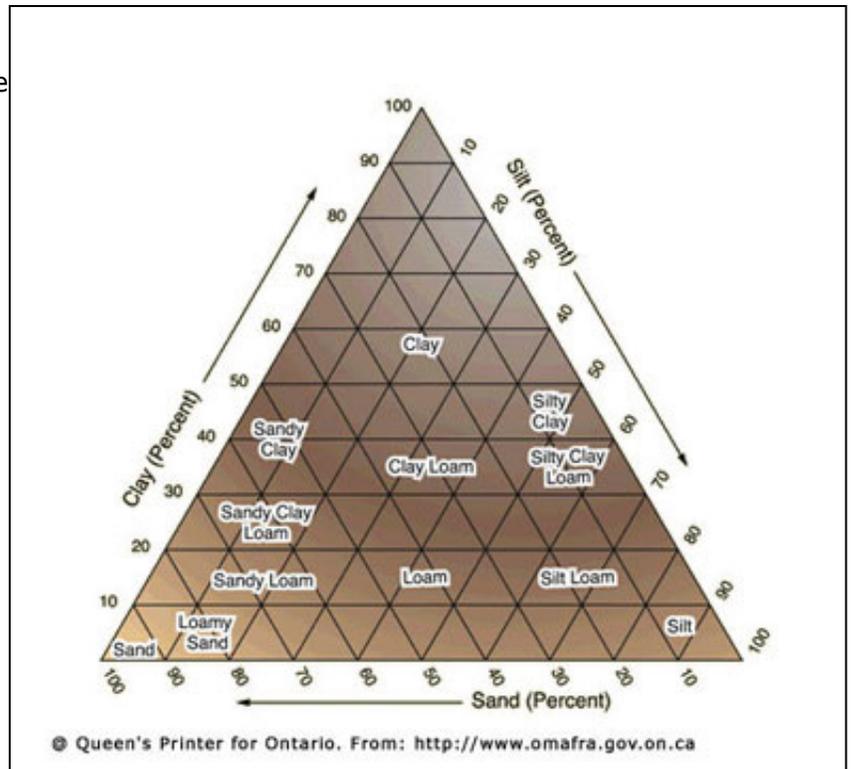
On the one hand, texture influences the capacity of roots to develop and extend into the soil. On the other hand, it has a direct impact on drainage, the capacity of soil to allow water to flow through. This characteristic is very important for the plant, because if soil does not evacuate water quickly enough, the roots are asphyxiated. If water drains too quickly, the tree doesn't have time to extract the mineral salts it requires. The nutritional elements then leach down deeper into the soil. A sticky soil composed primarily of clay is asphyxiating. A more granular soil like sand is well-aerated but dries out and heats up more quickly.



As a function of texture, there are three major types of soil:

- Sandy soil: 70% sand or more. Poor soil, aerated, dry (rapid drainage) and crumbly.
- Loamy soil: approximately 40% sand, 40% silt and 20% clay. Fertile soil, crumbly (chunky), aerated and humid.
- Clay soil: 25% clay or more. Fertile soil, sticky but asphyxiating (slow drainage).

In between these three major categories, there are a whole range of intermediary textures that can be identified using this diagram:



To learn more, visit the [Green Pages](#) of the Montréal Botanical Garden.

Answer key to Experiment 1

Last name, First name _____
Group n° _____

Introduction

The soil is fundamental for tree growth. Trees extract water and mineral salts from the earth to meet their nutritional requirements. The soil also anchors their roots, and constitutes the environment in which its seeds germinate. Soil type can be approximated through qualitative tests. Particles of sand make soil texture more granular and therefore crumbly. Smaller particles like clay give soil a sticky texture.

Experimental protocol**Material**

- Four 500 ml bowls or beakers
- One 250 g sample of each type of soil (A, B, C)
- A 250 g sample of soil D (optional)

1. Identify the bowls with the letters A, B, C (D optional).
2. Take a 250 g sample of each soil type and place one sample in each bowl.
3. Manipulate the soil samples between your fingers and note your observations in the chart below:

	Presence of grains	Malleability	Presence of clumps
Sample A (If loamy)	<u>Some</u>	<u>With some care, the soil can be shaped.</u>	<u>Yes</u>
Sample B (sandy)	<u>Yes</u>	<u>The soil sample runs through the fingers.</u>	<u>No</u>
Sample C (clayey)	<u>Very few</u>	<u>It is difficult to break the clumps.</u>	<u>Yes</u>
Sample D (optional)		<u>Depends on sample type.</u>	

4. Add 50 ml water to each bowl.
5. Manipulate the moistened soil samples with your fingers.

	Presence of grains	Malleability (ribbon and handful tests)	Presence of clumps
Sample A (If loamy)	<u>Yes, some</u>	<u>A bit sticky</u>	<u>Yes</u>
Sample B	<u>Yes, mostly</u>	<u>Not sticky</u>	<u>No</u>
Sample C	<u>Very little</u>	<u>Very sticky</u>	<u>Yes</u>
Sample D (optional)	<u>Depends on sample</u>	<u>Depends on sample</u>	<u>Depends on sample</u>

6. Compare your observations with the data in the chart below, and identify the texture type of the soil samples:

Soil texture	Dry soil	Moist soil
Sandy soils	<ul style="list-style-type: none"> Grains of sand are visible to the naked eye. Soil runs between the fingers like sugar. Soil is very granular and abrasive. 	<ul style="list-style-type: none"> Soil is very difficult to shape, breaks when touched. Soil doesn't stick to the fingers; rough and abrasive to the touch.
Clayey soils	<ul style="list-style-type: none"> Soil is composed of very hard clumps, and difficult to break. 	<ul style="list-style-type: none"> Soil is very sticky; it is smooth and shiny. Soil is very easy to shape; it can be shaped into long, flexible ribbons by rolling it between the hands.
Loamy soils	<ul style="list-style-type: none"> Soil is a little granular. Soil can be manipulated with care, without breaking up the clumps. 	<ul style="list-style-type: none"> Soil sticks a little and is a little granular. Soil can be rolled into a ribbon between the hands; ribbon cracks a little.

Texture of Sample A: depends on sample

Texture of Sample B: sandy soil

Texture of Sample C: clayey soil

7. Perform the tests to identify soil texture of Sample D, if appropriate. Then pour 50 ml water into the bowl and perform the tests to identify moist soil.

Description of the texture of sample D when dry:

Description of the texture of sample D when moist:

Texture of sample D:

Answer key to Experiment 2 worksheet

Last name, First name _____
Group n° _____

Introduction

Texture is one of the key characteristics of soil, one that determines which tree species will grow in it.

Texture is the proportion of each of three large particles of which soil is composed: sand, silt and clay. Grains of sand are the largest particles, and clay constitutes the smallest. Texture has a direct impact on drainage, that is, the capacity of soil to retain water. Quantitative tests are used to determine soil texture with precision.

Material required for each**Experiment 1**

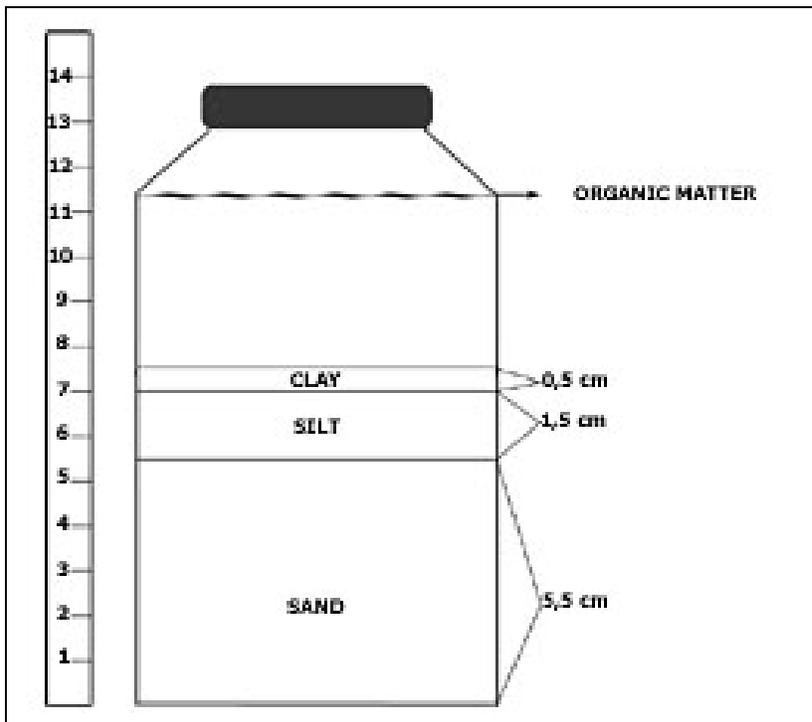
- Four 500 ml jars (including covers)
- A teaspoon
- Table salt
- 1 ruler
- One 250 g sample of each type of soil (A, B, C, D - optional) from Activity 1

Experiment 2

- 4 plastic pots for indoor plants, approx. 8-9 cm (3.5 inches) in diameter, with drainage holes
- A new batch of 250 g samples of each type of soil (A, B, C, D - optional)
- 1 stopwatch (or a watch with a second hand)

Protocol for Experiment 1: Measuring layers of soil

1. Identify the jars with the letters A, B, C, and D (optional).
2. Take the 250 g soil samples of each type of soil (A, B, C, and D – optional) from Activity 1 and place each sample in the appropriate jar.
3. Add water almost to the top of the jar. Add two teaspoons of salt to each jar.
4. Close the cover of each jar and shake it vigorously.
5. Allow the jars to stand for a minimum of 24 hours so that the earth settles at the bottom.
6. Then use a ruler to measure the thickness of each of the different soil layers visible as well as the total thickness of the soil.
7. Use the diagram below to fill out the results chart.



	Sand thickness	Silt thickness	Clay thickness	Total thickness
Sample A	<u>As a function of soil used</u>			
Sample B				
Sample C				
Sample D				

8. Based on the thickness of each layer, calculate the percentage of each element.

% sand: (sand layer thickness X 100) ÷ total thickness of soil in jar

% silt: (silt layer thickness X 100) ÷ total thickness of soil in jar

% clay: (clay layer thickness X 100) ÷ total thickness of soil in jar

	% sand	% silt	% clay
Sample A			
Sample B	<u>As a function of soil used</u>		
Sample C			
Sample D			

9. Then determine the soil type for each batch, using the chart below:

Soil texture	% sand	% silt	% clay
Sandy soil	70 and higher	0 to 30	0 to 15
Silty soil	0 to 20	80 and higher	0 to 15
Clayey soil	0 to 45	0 to 40	25 and higher
Loamy soil	40 to 60	30 to 50	15 to 25

	Type (soil texture)
Sample A	<u>As a function of soil used</u>
Sample B	<u>Sandy</u>
Sample C	<u>Clayey</u>
Sample D	<u>As a function of soil used</u>

10. Compare your results with those from Activity 1. Which method do you think is more reliable? Why?

Sample answer: We obtained similar results for each batch. Nonetheless, the second method seems more reliable because it includes quantitative measurements.

Protocol for Experiment 2: Calculating drainage time

1. Place a 250 g sample of each of the four soil batches into the planting pots, taking care to label each pot accordingly (A, B, C and D – optional).
2. Moisten each sample with approximately 15 ml water. Let stand 2 minutes.
3. Quickly pour 50 ml water onto each sample, and time how long it takes for the liquid to drain out of each soil, that is, the time until the first drop of water flows out of the drainage holes. Note the results in the chart below:

	Drainage time
Sample A	<u>As a function of soil used</u>
Sample B	
Sample C	
Sample D	

4. Using the chart below, describe the drainage of each of the four soils:

	Soils (A, B, C, D)
Good drainage: rainwater and melting snow is absorbed rapidly.	<u>As a function of soil used</u>
Moderate drainage: water drains easily but slowly, and sometimes accumulates for short periods.	
Imperfect drainage: water from precipitation or ground water sometimes accumulates for long periods.	
Poor drainage: water is constantly present, drains with difficulty and keeps soil humid year round.	

5. Using the data below and the results from your experiments, identify which tree species would be most appropriate for planting in Sample A (and D – optional).

	Good to moderate drainage	Imperfect to poor drainage
Sandy soil	White pine, red pine, red oak, northern whitecedar	White pine, larch, black spruce, willow, red ash
Loamy soil	White pine, red pine, white spruce, black spruce, northern whitecedar, sugar maple, red maple, white ash, red ash, red oak, black cherry, beech, linden, black walnut, butternut, shagbark hickory, bur oak	northern whitecedar, larch, black spruce, silver maple, red maple, willow, green ash
Clayey soil	White pine, white ash, red ash, northern whitecedar, beech, black walnut, butternut, bur oak	larch, black spruce, silver maple, red ash, willow

Source :

http://www.treecanada.ca/programs/urbanforestry/cufn/Resources_Canadian/ChoosingRightTree.pdf

Answer(s): As a function of soil used.

Last name, First name _____
Group n° _____

Introduction

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Experimental protocol

Material

- Four 500 ml bowls or beakers
- One 250 g sample of each type of soil (A, B, C)
- A 250 g sample of soil D (optional)

8. Identify the bowls with the letters A, B, C (D optional).
9. Take a 250 g sample of each soil type and place one sample in each bowl.
10. Manipulate the soil samples between your fingers and note your observations in the chart below:

	Presence of grains	Malleability	Presence of clumps
Sample A			
Sample B (sandy)			
Sample C (clayey)			
Sample D (optional)			

11. Add 50 ml water to each bowl.
12. Manipulate the moistened soil samples with your fingers.

	Presence of grains	Malleability (ribbon and handful tests)	Presence of clumps
Sample A			
Sample B			
Sample C			
Sample D (optional)			

13. Compare your observations with the data in the chart below, and identify the texture type of the soil samples:

Soil texture	Dry soil	Moist soil
Sandy soils	<ul style="list-style-type: none"> Grains of sand are visible to the naked eye. Soil runs between the fingers like sugar. Soil is very granular and abrasive. 	<ul style="list-style-type: none"> Soil is very difficult to shape, breaks when touched. Soil doesn't stick to the fingers; rough and abrasive to the touch.
Clayey soils	<ul style="list-style-type: none"> Soil is composed of very hard clumps, and difficult to break. 	<ul style="list-style-type: none"> Soil is very sticky; it is smooth and shiny. Soil is very easy to shape; it can be shaped into long, flexible ribbons by rolling it between the hands.
Loamy soils	<ul style="list-style-type: none"> Soil is a little granular. Soil can be manipulated with care, without breaking up the clumps. 	<ul style="list-style-type: none"> Soil sticks a little and is a little granular. Soil can be rolled into a ribbon between the hands; ribbon cracks a little.

Texture of Sample A:

Texture of Sample B:

Texture of Sample C:

14. Perform the tests to identify soil texture of Sample D, if appropriate. Then pour 50 ml water into the bowl and perform the tests to identify moist soil.

Description of the texture of sample D when dry:

Description of the texture of sample D when moist:

Texture of sample D:

Last name, First name _____
Group n° _____

Introduction

Texture is one of the key characteristics of soil, one that determines which tree species will grow in it.

Texture is the proportion of each of three large particles of which soil is composed: sand, silt and clay. Grains of sand are the largest particles, and clay constitutes the smallest.

Texture has a direct impact on drainage, that is, the capacity of soil to retain water.

Quantitative tests are used to determine soil texture with precision.

Material required for each

Experiment 1

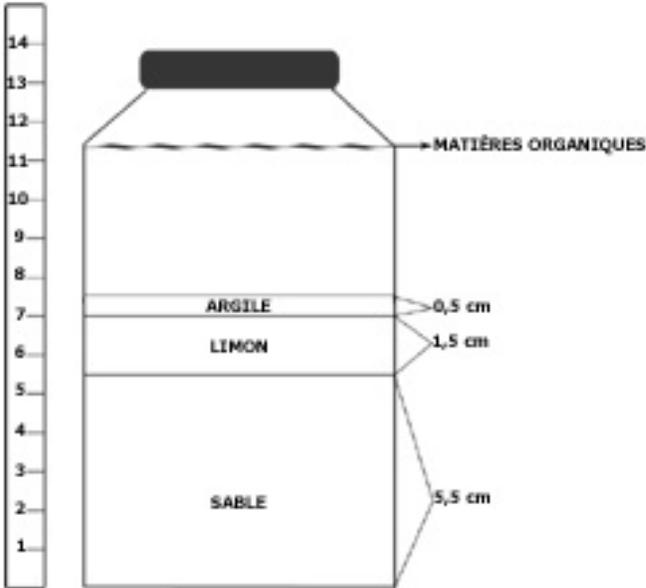
- Four 500 ml jars (including covers)
- A teaspoon
- Table salt
- 1 ruler
- One 250 g sample of each type of soil (A, B, C, D - optional) from Activity 1

Experiment 2

- 4 plastic pots for indoor plants, approx. 8-9 cm (3.5 inches) in diameter, with drainage holes
- A new batch of 250 g samples of each type of soil (A, B, C, D - optional)
- 1 stopwatch (or a watch with a second hand)

Protocol for Experiment 1: Measuring layers of soil

1. Identify the jars with the letters A, B, C, and D (optional).
2. Take the 250 g soil samples of each type of soil (A, B, C, and D – optional) from Activity 1 and place each sample in the appropriate jar.
3. Add water almost to the top of the jar. Add two teaspoons of salt to each jar.
4. Close the cover of each jar and shake it vigorously.
5. Allow the jars to stand for a minimum of 24 hours so that the earth settles at the bottom.
6. Then use a ruler to measure the thickness of each of the different soil layers visible as well as the total thickness of the soil.
7. Use the diagram below to fill out the results chart.



	Sand thickness	Silt thickness	Clay thickness	Total thickness
Sample A				
Sample B				
Sample C				
Sample D				

8. Based on the thickness of each layer, calculate the percentage of each element.

% sand: (sand layer thickness X 100) ÷ total thickness of soil in jar

% silt: (silt layer thickness X 100) ÷ total thickness of soil in jar

% clay: (clay layer thickness X 100) ÷ total thickness of soil in jar

	% sand	% silt	% clay
Sample A			
Sample B			
Sample C			
Sample D			

9. Then determine the soil type for each batch, using the chart below:

Soil texture	% sand	% silt	% clay
Sandy soil	70 and higher	0 to 30	0 to 15
Silty soil	0 to 20	80 and higher	0 to 15
Clayey soil	0 to 45	0 to 40	25 and higher
Loamy soil	40 to 60	30 to 50	15 to 25

	Type (soil texture)
Sample A	
Sample B	
Sample C	
Sample D	

10. Compare your results with those from Activity 1. Which method do you think is more reliable? Why?

Protocol for Experiment 2: Calculating drainage time

1. Place a 250 g sample of each of the four soil batches into the planting pots, taking care to label each pot accordingly (A, B, C and D – optional).
2. Moisten each sample with approximately 15 ml water. Let stand 2 minutes.
3. Quickly pour 50 ml water onto each sample, and time how long it takes for the liquid to drain out of each soil, that is, the time until the first drop of water flows out of the drainage holes. Note the results in the chart below:

	Drainage time
Sample A	
Sample B	
Sample C	
Sample D	

4. Using the chart below, describe the drainage of each of the four soils:

	Soils (A, B, C, D)
Good drainage: rainwater and melting snow is absorbed rapidly.	
Moderate drainage: water drains easily but slowly, and sometimes accumulates for short periods.	
Imperfect drainage: water from precipitation or ground water sometimes accumulates for long periods.	
Poor drainage: water is constantly present, drains with difficulty and keeps soil humid year round.	

5. Using the data below and the results from your experiments, identify which tree species would be most appropriate for planting in Sample A (and D – optional).

	Good to moderate drainage	Imperfect to poor drainage
Sandy soil	White pine, red pine, red oak, northern whitecedar	White pine, larch, black spruce, willow, red ash
Loamy soil	White pine, red pine, white spruce, black spruce, northern whitecedar, sugar maple, red maple, white ash, red ash, red oak, black cherry, beech, linden, black walnut, butternut, shagbark hickory, bur oak	Northern whitecedar, larch, black spruce, silver maple, red maple, willow, green ash
Clayey soil	White pine, white ash, red ash, northern whitecedar, beech, black walnut, butternut, bur oak	Larch, black spruce, silver maple, red ash, willow

Source :

http://www.treecanada.ca/programs/urbanforestry/cufn/Resources_Canadian/ChoosingRightTree.pdf

Answer(s):