

SI Environmental Science - Full Discipline Demo

Properties of Soil

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Environmental Science - Full Discipline Demo
Course	SI Environmental Science - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

⚡ Humus	➡	The unconsolidated mixture of minerals and organic matter on the surface of the earth that functions as medium for growing plants	1	
⚡ Parent material		Decaying organic materials	2	
⚡ Permeability		Large soil particles between 0.5 - 2.0 mm in size	3	
⚡ Porosity		A measure of the ease with which water is transported through the soil	4	
⚡ Sand		A measure of the soil's ability to store water	5	
⚡ Soil		Unweathered bedrock present in the R horizon	6	

Correct answers:

- 1 Soil 2 Humus 3 Sand 4 Permeability 5 Porosity
6 Parent material

Order the soil layers from top to bottom.

≡ A horizon

1 **Correct answer:** O horizon

≡ B horizon

2 **Correct answer:** A horizon

≡ C horizon

3 **Correct answer:** B horizon

≡ O horizon

4 **Correct answer:** C horizon

≡ R horizon

5 **Correct answer:** R horizon

Classify each statement as true or false.

⚡ Arid regions are more commonly associated with acidic soils.	
⚡ Carbon (C), phosphorus (P), and potassium (K) are the primary nutrients found in soil.	
⚡ Soil pH influences nutrient absorption and plant growth.	
⚡ Soils that are a mixture of sand, silt, and clay are called loams.	
⚡ The optimum pH for plant growth is between 3.5 - 4.5.	
⚡ The percentage of clay, silt, and sand particles in the soil determine the soil's texture.	
True	False
1	2

Correct answers:

1 Soils that are a mixture of sand, silt, and clay are called loams.

The percentage of clay, silt, and sand particles in the soil determine the soil's texture.

Soil pH influences nutrient absorption and plant growth.

2 Arid regions are more commonly associated with acidic soils.

The optimum pH for plant growth is between 3.5 - 4.5.

Carbon (C), phosphorus (P), and potassium (K) are the primary nutrients found in soil.

Exploration

Soil provides a habitat for ____.

- ☐ bacteria
- ☐ fungi
- ☐ arthropods
- ☒ All of the above

✓

Topsoil is found in the ____ horizon.

- ☒ A
- ☐ B
- ☐ C
- ☐ R

✓

____ comprises chemically active minerals that attract water.

- ☐ Sand
- ☐ Silt
- ☒ Clay
- ☐ Humus

✓

Soil texture determines the volume of water that soils can store and transport.

- ☒ True
- ☐ False

✓

A pH range of ____ is ideal for most plant species.

- ☐ 2.5-3.6
- ☐ 4.1-5.3
- ☒ 6.0-6.8
- ☐ 8.2-9.4

✓

_____ is a soil macronutrient required for plant metabolism and growth.

- ☐ Nitrogen
- ☐ Phosphorus
- ☐ Potassium
- ☒ All of the above



Exercise 1

How does soil pH influence the availability of nutrients for plant uptake? Which of the pH results recorded in Data Table 1 were outside the ideal range for nutrient availability?

Soil pH determines the solubility of most nutrients essential for plant growth. The macronutrients nitrogen, phosphorus, and potassium are soluble in the acidic pH range of 6.0-6.8. pH levels significantly below or above this range will result in these nutrients becoming unavailable for plant root uptake. pH of sand was alkaline (8.0), as recorded in Data Table 1, and nutrient levels tested low for this sample.

Which (if any) of the tested soils were ideal for growing plants? Reference Data Table 1 in your answer.

The test results by SI suggest none of the three soils were ideal for growing plants. Sand had no available nutrients and an alkaline pH of 8.0. Silt had adequate phosphorus and potassium, but insufficient nitrogen. The topsoil sample was rich in nitrogen, but lacked sufficient potassium and phosphorus.

Data Table 1: Chemical Properties of Soils
(SAMPLE ANSWER BELOW)

	Silt	Sand	Topsoil
pH	7.0	8.0	6.0 Note: topsoil values for pH, nitrogen, phosphorus, and potassium vary per soil vendor. Nitrogen levels should match Photo 1.
Nitrogen	Low	Low	High

Phosphorus	Medium	Low	Low
Potassium	Medium	Low	Low

Photo 1: Nitrogen Test Results for Topsoil
(SAMPLE ANSWER BELOW)

Note to Instructor: SI topsoil samples exhibit variability in chemical characteristics based on collection site by the vendor. However, the solution color in the student photo should match the nitrogen level recorded by the student in Data Table 1.

Exercise 2

How is porosity related to the bulk density of soil? Do your results in Data Table 2 support this relationship?

Porosity is a measure of the space between soil particles and is inversely related to the bulk density of soil. A less dense soil should have a higher porosity value than a denser soil. The results for porosity and bulk density in Data Table 2 support this relationship. Clay had the lowest bulk density and highest porosity value, whereas sand had the highest bulk density and lowest porosity value.

Which of the tested soil samples would permit the easiest transport of water to plant roots? Reference Data Table 2 and the definition of permeability in your answer.

The sand sample would permit the easiest flow of water to plant roots. Permeability is the measure of ease of water transport in soil. In Data Table 2, sand had the highest permeability measure of 1.0.

Data Table 2: Soil Weight and Porosity
(SAMPLE ANSWER BELOW)

	Clay	Silt	Sand	Topsoil
Weight of 25 mL dry soil (g)	21.6	27.7	38.0	30.7
Bulk density (g/mL)	0.864	1.10	1.52	1.23
Volume of water used for soil saturation (mL)	65.0	18.0	10.0	13.0
Soil porosity (%)	260.0	72.0	40.0	52.0
Distance water traveled in 5 min (cm)	0.10	4.0	5.0	3.0
Soil permeability (cm/min)	0.020	0.80	1.0	0.60

Exercise 3

Which of the samples in Figure 12 would be ideal for growing agricultural plants? Explain your answer by referencing Data Table 3.

Samples A and C would be ideal for most agricultural plants since they are both classified as loams, which are considered ideal soils.

Apply your knowledge of the physical properties of soil to explain why soil mixtures of > 60% clay are classified as only "clay" on the soil classification triangle.

The porosity and permeability of clay are significantly different than those of silt and sand. Clay is an active mineral particle that bonds with water molecules, prohibiting the movement of water within the soil matrix. Sand and silt particles are inactive and permit the movement of water within the soil matrix. When a soil mixture contains > 60% clay, these small particles fill all void spaces between the larger silt and sand particles and prohibit the flow of water through the soil.

Data Table 3: Classification of Separated Soil
(SAMPLE ANSWER BELOW)

	Sample A	Sample B	Sample C
Sand volume (mL)	24	12	42
Silt volume (mL)	25	18	13
Clay volume (mL)	11	30	5
Total volume (mL)	60	60	60
% sand	40	20	70
% silt	42	30	22
% clay	18	50	8
Classification	Loam	Clay	Sandy loam

Competency Review

The diversity of life supported by soil is determined by its chemical and physical properties.

- ☐ True ✓
- ☐ False

_____ is a measure of the soil's ability to store water.

- ☐ Humus
- ☒ Porosity ✓
- ☐ Permeability
- ☐ pH

The uppermost soil layer is the A horizon.

- ☐ True
- ☒ False ✓

The B horizon, or subsoil, is composed of _____.

- ☐ humus
- ☐ living organisms
- ☒ mineral particles ✓
- ☐ bedrock

_____ particles are 0.5 - 2.0 mm and commonly composed of quartz .

- ☒ Sand ✓
- ☐ Silt
- ☐ Clay
- ☐ Humus

Loams are ideal for growing most agricultural crops.

- ☒ True ✓
- ☐ False

Soil ____ determines the solubility of plant nutrients.

- ☒ pH ✓
- ☐ permeability
- ☐ texture
- ☐ porosity

____ is a macronutrient derived from the decomposition of parent material.

- ☐ Nitrogen
- ☐ Phosphorus
- ☒ Potassium ✓
- ☐ Zinc

Soil samples must be saturated with ____ before testing pH and nutrient levels.

- ☐ alcohol
- ☒ distilled water ✓
- ☐ saline solution
- ☐ vinegar

Clay and sand have similar porosity values.

- ☐ True
- ☒ False ✓

Soils consisting of > 60% clay particles are termed loams.

☐ True

☒ False



Extension Questions

A soil scientist has been contracted by a garden supply company to develop a soil mixture targeted to gardeners in the desert southwest of the United States. The native soils of this region tend to be alkaline and sandy. Describe the soil mixture that the scientist should create for gardening in this arid environment and explain how its components, when mixed with the existing sandy soil, will improve growing conditions for garden plants.

(SAMPLE ANSWER BELOW)

The scientist should create a mixture that is rich in humus and silt, with a small amount of clay. The humus will provide decaying organic material that will increase the nitrogen and phosphorus levels of the soil and also lower the pH of the soil, making these macronutrients more soluble and available to plants. The addition of clay will attract potassium ions and prevent them from being leached. The silt and clay in the mixture will increase the porosity of the soil and also slow the movement of water outside the zone where the plant roots reside due to evaporation and gravity. When mixed with the existing sandy soil, a topsoil layer will exist that is suitable for garden plants.