| **Homegrown Gardening Through the Lens of Soil Science**  Authors: Stephen McBride & Brooke Stafford | | |
| --- | --- | --- |
| **Unit Overview** | | |
| **Target Audience:** 5th grade | **Est. Time:** 5 lessons, 45-minutes per lesson | **Content Area(s):** Biology, Chemistry, & Product Development |
| **Abstract:**  In this unit, students will employ engineering design and modeling to learn about the life science principles involved in creating a sustainable plant growing system in the form of a terrarium. Through the agricultural context of soil science, STEM integration will take place during each lesson promoting deeper student connections with the content being taught. Students will participate in five lessons related to soil science and water impacts on plant growth. In the first lesson, students will be introduced to soil types and learn about soil particle sizes as well as the science behind capillary activity. The second lesson will give students a chance to use science to visualize the differences in pH levels and gain knowledge about nutrients held within soil. The third lesson educates students about qualities of different soil types, water flow/percolation within soil, and proper combinations of soil types for plants. In the fourth lesson, students will develop an understanding about the different soil combinations needed in small, urban settings for optimal plant growth by using problem-solving approaches to develop solutions that adjust soil and water conditions of a small garden space. They will use all of the knowledge gained to design and construct a terrarium of their choice with a variety of soil materials provided in the fifth lesson. The instructors are able to incorporate the concepts of science, mathematics, and engineering through this mini-unit on soil science. | | |
| **Unit Goals/Objectives:**  After this unit, students will be able to:   1. Explain the chemistry of capillary action within soil. 2. Analyze the characteristic differences between the soil types of sand, silt, and clay. 3. Determine the proper soil environment for optimal plant growth in different settings. 4. Categorize pH values as acidic or basic. 5. Describe the differences in acids and bases and their relation to soil quality. 6. Identify how soil pH affects plant growth. 7. Relate the process of percolation and the importance of water flow within soil to plant growth. 8. Assess plant growth problems and formulate recommendations for improved growing quality based on evidence of soil and water conditions. 9. Identify solutions to commonly seen soil and water problems for plant development 10. Explain a prototype design of a plant environment based on scientific evidence to optimize plan efficiency. | | |
| **Lesson Summaries:**  Lesson 1: Introduction to Soil Sciences   1. Explain the chemistry of capillary action within soil. 2. Analyze the characteristic differences between the soil types of sand, silt, and clay.   Lesson 2: pH Impacts Plant Health   1. Categorize pH values as acidic or basic. 2. Describe the differences in acids and bases and their relation to soil quality. 3. Identify how soil and water pH affects plant growth   Lesson 3: Soil and Water Flow   1. Determine the proper soil environment for optimal plant growth in different settings. 2. Relate the process of percolation and the importance of water flow within soil to plant growth   Lesson 4: Homegrown Food   1. Assess plant growth problems and formulate recommendations for improved growing quality based on evidence of soil and water conditions. 2. Identify solutions to commonly seen soil and water problems for plant development   Lesson 5: Terrarium Construction   1. Explain a prototype design of a plant environment based on scientific evidence to optimize plant efficiency | | |
| **Lesson Timeline:**  Lesson 1: Introduction to Soil Sciences   * Introduction (12 minutes) * Capillary Action Activity (15 minutes) * Soil Particles Exploration (15 minutes) * Wrap Up (3 minutes)   Lesson 2: pH Impacts Plant Health   * Introduction (2 minutes) * Water pH Activity (22 minutes) * Think-Pair-Share (3 minutes) * Soil pH Activity (10 minutes) * Debrief/Processing (5 minutes) * Review & Closure (3 minutes)   Lesson 3: Soil and Water Flow   * Introduction (2 minutes) * Water Flow/Percolation Activity (30 minutes) * Debrief/Processing (8 minutes) * Review & Closure (3 minutes) * 3-2-1 Notecards (2 minutes)   Lesson 4: Homegrown Food   * Introduction (2 minutes) * Homegrown Food & Save Sam’s Garden Activity (40 minutes) * Wrap Up (3 minutes)   Lesson 5: Terrarium Construction   * Introduction (7 minutes) * Terrarium Activity (20 minutes) * Terrarium Design Presentations (10 minutes) * Review & Close (3 minutes) * Summative Assessment Post-Test (5 minutes) | | |
| **Standards:**  **Indiana Department of Education Standards**  **3-5.E.1** Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.  **IAFNR-4.2** Prepare and implement plant management strategies that address environmental factors, essential nutrients, and soil management practices for productive plant growth  **IAFNR-4.3** Identify the physical qualities of the soil that determine its use  **EA-3.1** Understand basic needs of plant growth from germination to soil fertility  **EA-3.4** Identify basic soil properties  **C.8.1** Classify solutions as acids or bases and describe their characteristic properties  **C.8.2** Compare and contrast the strength of acids and bases in solutions  **Next Generation Science Standards (NGSS)**  **5-LS1-1** Support an argument that plants get the materials they need for growth chiefly from air and water.  **5-PS1-3** Make observations and measurements to identify materials based on their properties  **5-PS1-4** Conduct an investigation to determine whether the mixing of two or more substances results in a new substance | | |
| **STEM Integration within the Unit:** | | |

| **Lesson 1: *Introduction to Soil Sciences*** | | | |
| --- | --- | --- | --- |
| **Est. Time:** 45 minutes | | | |
| **Lesson Learning Goals/Objectives:**   1. Explain the chemistry of capillary action within soil. 2. Analyze the characteristic differences between the soil types of sand, silt, and clay. | | **Standards:**  **Indiana Department of Education Standards**  **EA-3.4** Identify basic soil properties  **Next Generation Science Standards (NGSS)**  **5-LS1-1** Support an argument that plants get the materials they need for growth chiefly from air and water.  **5-PS1-3** Make observations and measurements to identify materials based on their properties | |
| **Assessments**  **Pre-Assessment:**  Summative assessment pre-test  **Formative:**  Questions and Observation, “Investigating Soils as a Soil Scientist” worksheet | | | |
| **Concept Prerequisites or Background Knowledge Needed:** | | | |
| **Vocabulary:**  sand, silt, clay, capillary action, capillary | | | |
| **Materials & Technology Needed:**  Clear cups  Sand  Silt  Clay  “L1: Investigating Soil as a Soil Scientist” worksheet  Water  White Coffee Filters  White Paper Towels  White Tissue Paper  Washable Markers  Three clear jars or bottles with lids (same sized containers)  Basketball  Golf ball | | | |
| **Before Lesson Preparation**   * Fill clear plastic cups solely with sand, silt, or clay so that every group of three students has one cup of sand, one cup of silt, and one cup of clay. * Print off the “L1: Investigating Soil as a Soil Scientist” worksheet for each student | | | |
|  | | | |
| **Lesson Component** | **Instructions** | | **Materials** |
| **Introduction**  *12 minutes* | Provide objectives and overview of the lesson.  Introduce what a soil scientist does:   * A soil scientist studies the properties of Earth’s crust (which includes topsoil) and its physical, chemical, and biological properties * Roles within this career include:   + Agriculture - test soil quality for best crop growth   + Forestry - measure effects of tree density on soil   + Urban Spaces - determines soil mixture needed for plant growth in small spaces (i.e. landscaping, community gardens, box gardens, flower beds)   + Environment - control soil erosion rates   Share with students their role within the unit acting as a junior soil scientist who has the job of designing the optimal soil environment for a plant to grow in a terrarium.   * This is similar to a soil scientist who works in urban settings designing soil compositions for small garden beds or landscaping.   Students will take the Summative Assessment Pre-test to assess their current knowledge of a junior soil scientist  Allow students to take turns interacting with the sand, silt, and clay when finished. Encourage them to make observations of texture, feel, size, and appearance. | | Summative assessment pre-test |
| **Instructional Activities**  *30 minutes* | **Capillary Action Activity (15 minutes)**  Ask students how plants get water and nutrients they need to grow.   * Expect answers like: Rain, from the ground, etc.   Introduce students to capillary action by asking questions about gravity and water.   * Does water rise toward the sky when it rains or fall down to the Earth? * Can a stream of water flow uphill, or does it only go downhill? * Today we will see how water can flow upward (and I don’t mean by magic).   Define capillary action: the ability of a liquid to flow through narrow spaces without the assistance or limitation of gravity.   * This is how plants are able to soak up water and nutrients from the soil to their stems and leaves!   Begin Capillary Action Activity.   * Direct students to materials on their tables:   + Cups of water   + Markers   + Absorbent materials: Coffee Filters, Paper Towels, Tissue Paper * Ask students to write down which material will soak the water up the fastest and what they think will happen (save for later). * Students work in groups of 3:   + One will choose coffee filter, another will have a paper towel, and the final group member will have tissue paper   + They each choose a different colored marker   + They will draw a circle 3” diameter on their chosen material and then fold the material around the circle into eighths * Students will place the bottom, pointed end of their triangles about a millimeter into the water, and they will see which material soaked up the water the fastest and what happened when the water reached the mark they had drawn.   Have students make a note of how long the water took to make its way through their material and their observations of what was happening.  Ask the group to share what they learned.  Ask the group to compare their hypotheses with what actually happened.   * Have 1 or 2 students share   Ask the students to recap what Capillary Action is and how plants get their nutrients and water.  Have students complete the Capillary Action activity on the L1 worksheet.  Transition to the next activity | | Clear Cups  Water  White Coffee Filters  White Paper Towels  White Tissue Paper  Washable Markers  “L1: Investigating Soil as a Soil Scientist” worksheet |
| **Soil Particles Exploration (15 Minutes)**  Explain soil composition and particle size.  Ask students which soil type (sand, silt, or clay) has the largest particle size based on their observations and photos provided on the worksheet.   * Fill out the particle size pre-activity question on the worksheet.   Position the three clear containers in a row at the front of the class so all students can see them and fill each to the top with water.  Ask students which soil type will sink to the bottom the fastest and why.  Simultaneously add sand to one container, silt to the second, and clay to the third.   * For help with this activity, ask for 3 student volunteers to assist.   Allow students to write down their observations within the table in the worksheet.  Place lids on the top of each container and shake to stir up the soil in the water.  Allow students to write down their observations in the worksheet table.  Ask students:   * Which soil type is cloudy and which soil type is clear in the water?   Discuss the results with students and explain that sand has the largest particle size and settles to the bottom first due to gravity. The soils with smaller particle sizes interact with the water, stay suspended longer, and take the longest time to settle to the bottom.   * Particle sizes in order from largest to smallest: sand, silt, clay.   Hold up the basketball and golf ball. Explain that the size difference between a basketball and a golf ball represents the same size difference between the soil with the largest and smallest particle size.  Ask students which soil type is represented by the basketball and which soil type is represented by the golf ball.   * Expect answers of: the basketball represents the sand and the golf ball represents the clay.   Have students complete the final question of the worksheet based on what they have learned. | | “L1 Investigating Soil as a Soil Scientist” worksheet  Three clear jars or bottles with lids (same sized containers)  Water  Sand  Silt  Clay  Basketball  Golf ball |
| **Wrap Up,**  **Synthesis/Closure**  *3 minutes* | The instructor will tie the lesson into the greater objective of the unit for review and close the session.  Students will hand in their completed worksheets at the end of the lesson. | |  |
|  | | | |
| **Resources:**  Activity adopted from: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054300> | | | |

| **Lesson 2: *pH Impacts Plant Health*** | | | |
| --- | --- | --- | --- |
| **Est. Time:** 50 minutes | | | |
| **Lesson Learning Goals/Objectives:**   1. Categorize pH values as acidic or basic. 2. Describe the differences in acids and bases and their relation to soil quality. 3. Identify how soil and water pH affects plant growth | | **Indiana Department of Education Standards**  **C.8.1** Classify solutions as acids or bases and describe their characteristic properties  **C.8.2** Compare and contrast the strength of acids and bases in solutions  Next Generation Science Standards (NGSS)  **5-PS1-4** Conduct an investigation to determine whether the mixing of two or more substances results in a new substance | |
| **Assessments**  **Formative:**  Questions and Observation, Think-Pair-Share, “pH Paper Test Activity” worksheet | | | |
| **Concept Prerequisites or Background Knowledge Needed:**  Lesson 1 content | | | |
| **Vocabulary:**  pH, acidic, basic | | | |
| **Materials & Technology Needed:**  20 total clear jars  Salt water  Pond water  Tap water  Filtered water  Vinegar  Baking Soda  Lesson 2 pH Test Activity worksheet  pH Paper Test Kit  Sand soil  Clay soil  12 small cups  Different water types listed above  8 jars prepared above  pH Paper Test Kit  Labels | | | |
| **Before Lesson Preparation**   * The instructor will fill jars with the following solutions:   + Salt Water   + Pond/Outside Water   + Tap Water   + Filtered Water   + Vinegar & Water (2 jars: 1 class example & 1 for random sample)   + Baking Soda & Water (2 jars: 1 class example & 1 for random sample) * The instructor should perform a pH Paper Test on each solution and record the pH of each for later discussion with students. (Set pH values are not provided as they vary between solutions and will differ by location water is retrieved.) * Print off the Lesson 2 pH Test Activity worksheet for each student * The instructor should prepare 6 small cups with sand and 6 small cups with clay soil. * Fill 12 clear jars with filtered water. | | | |
|  | | | |
| **Lesson Component** | **Instructions** | | **Materials** |
| **Introduction**  *2 minutes* | Provide objectives and overview of the lesson | |  |
| **Instructional Activities**  *35 minutes* | **Water pH Activity (22 minutes)**  Randomize a set of jars filled with the different types of water around the classroom (labeled):   * Salt Water * Pond/Outside Water * Tap Water * Filtered Water * Vinegar & Water * Baking Soda & Water   Direct students to a place in the room where the instructor will demonstrate how to perform a pH Paper Test to determine the pH of vinegar water and baking soda water to show a very acidic solution (vinegar) and a very basic solution (baking soda).  Ask students:   * Have you ever heard of an acid or a base? * What does the word “acidic” mean? * What does “basic” mean?   The instructor will explain the difference in acids and bases.  Tell students that the pH scale is a measurement of how acidic or basic a solution is. The scale ranges from 1 to 14 with measures closer to 1 indicating very acidic and measures closer to 14 being very basic.  Explain that a pH Paper Test is a way to measure pH. Describe how the test works and show students that the resulting color of the pH paper can be compared to a pH color chart (contained in the pH Paper Test Kits).  Perform the pH Paper Test again with the vinegar and baking soda solutions showing students how the test works.  Divide students into 6 groups. Assign one group to each solution sample station and establish the group rotation schedule in timed intervals. Hand each group a pH Paper Test kit.  Have student groups begin the pH tests on the samples and fill in their results on the pH Test table. Rotate stations every 2 minutes or as needed.  Have students answer the two questions on the worksheet after they are finished.  Discuss the results as a class.  Ask students:   * Which sample was the most basic? How could you tell that from the pH Paper Test? * Which sample was the most acidic? How could you tell from the test?   Explain how water pH can be changed with the addition of different solutions.  Discuss how this is applicable to water given to plants.  Transition to soil pH activity | | Different water types listed above  8 jars prepared above  pH Paper Test Kit  Labels |
| **Think-Pair-Share (3 minutes)**  Ask students:   * As a Junior Soil Scientist, why do you think pH is important in soil? Think about your answer, discuss your answers with the person sitting next to you, and then we will share our answers with the class | |  |
| **Soil pH Activity (10 minutes)**  Explain to students that pH is important for healthy soil. The pH of the soil can affect how plants retrieve nutrients and grow.  Tell students: There is often a soil pH range that plants like to grow in. If the pH is outside of that range, the plants may not grow properly or even die. In Lesson 4 we will see examples of soil pH ranges that most vegetable plants like to live in. We can easily test the soil pH like we did for water.  Have students work in the same small groups as for the water pH activity. Each should retrieve a pH paper test kit, 2 clear jars filled with filtered water, 1 cup of sand soil, and 1 cup of clay soil.  Ask a group, pour the soils into their respective jars of water. Place the lids on the jars and shake the soil water mixtures. Perform a pH paper test on both samples.  Have students work as a group to determine the pH based on the paper color.  Discuss the resulting soil pH’s as a class | | Pre-prepared:  6 small cups of sand soil  6 small cups of clay soil  12 clear jars with filtered water  pH paper test kits |
| **Wrap Up,**  **Synthesis/Closure**  *8 minutes* | **Debrief/Processing (5 minutes)**  Discuss the effects of acids and bases to plant growth and soil quality.  Have students share why soil pH is important as a soil scientist.  Explain what can be done to change the pH of the soil to a range that is optimal for plant growth.   * pH can be raised by adding limestone. * pH can be lowered by adding sulfur | |  |
| **Review & Close (3 minutes)**  Students will be asked to recap the lesson for the group   * One student will provide the process of the first activity and another will explain the greater meaning. * Repeat this process for the second activity.   The instructor will tie the lesson into the greater objective of the unit for review and close the session | |  |
|  | | | |
| **Resources:** | | | |

| **Lesson 3: *Soil and Water Flow*** | | | |
| --- | --- | --- | --- |
| **Est. Time:** 50 minutes | | | |
| **Lesson Learning Goals/Objectives:**   1. Determine the proper soil environment for optimal plant growth in different settings. 2. Relate the process of percolation and the importance of water flow within soil to plant growth | | **Indiana Department of Education Standards**  **IAFNR-4.3** Identify the physical qualities of the soil that determine its use  **EA-3.4** Identify basic soil properties | |
| **Assessments**  **Formative:**  Questions and Observation, 3-2-1 Notecards | | | |
| **Concept Prerequisites or Background Knowledge Needed:**  Lesson 1 - 2 content, sand, silt, clay distinction | | | |
| **Vocabulary:**  topsoil, water retention, porous | | | |
| **Materials & Technology Needed:**  Technology screen  Plastic cups  Water  Funnels  Filter paper  Clay  Silt  Topsoil  Sand  gravel | | | |
| **Before Lesson Preparation**  The instructor needs to prepare the technology to display the photo of plants receiving different levels of water. The website is provided below.  The instructor will prepare funnels for the students by placing filter paper inside each funnel. Each group of 5 students needs 5 funnels prepared.  The instructor will prepare cups of soil such that each cup will contain 1 cup of soil. Each group of 5 students needs 1 cup of each of the following soils: clay, silt, topsoil, sand, and gravel.  The instructor will prepare cups of water such that each cup contains 1 cup of water. Each group of 5 students needs 5 total cups of water | | | |
|  | | | |
| **Lesson Component** | **Instructions** | | **Materials** |
| **Introduction**  *2 minutes* | Provide objectives and overview of the lesson. | |  |
| **Instructional Activities**  *30 minutes* | **Water Flow/Percolation Activity (30 Minutes)**  Display photos of the same plant watered in different amounts: very little water, right amount of water, and overwatering. This site has a great photo comparing overwatering and underwatering of the same plant: <https://www.binleyflorist.com/index.php/news/gardening-tips/216-overwatered-houseplants-fixing-the-damage>  Ask students:   * What do you see as differences between the plant that is overwatered, underwatered, and watered the correct amount? * Do you think anything else can contribute to a plant getting too much water or too little water besides the amount of water we give it? If so, what would that be?   Invite students to think about this problem through the lens of a junior soil scientist.  Ask students to discuss with a partner and share:   * From what we have learned, what might a soil scientist investigate within the soil that could affect how much water a plant gets?   Discuss how the soil type can also affect the amount of water a plant gets. Water flows through soils at different rates. Refer back to the first lesson with particle size. The smaller particle sizes stick closer together which means that more water can be held in these soils. The larger particle sizes have bigger holes between particles so the water flows out of these soils more quickly.  Explain what percolation is.   * It is moving and filtering fluids through porous material.   Relate the particle size and percolation together.  Introduce the 5 soils:   * Gravel * Sand * Silt * Clay * Topsoil   Divide students into groups of 5. Make sure every group has the 5 soil samples, 5 paper funnels, 5 water cups, and 5 empty cups.  Allow time for students to feel the soils and make observations regarding size and texture of each soil.  In groups of 5, have students write down on the printer paper their ranking predictions for the order that water will run through the soils from fastest to slowest as well as predictions for which soils will retain the most water.  Have groups share their hypotheses with the class.  Instruct groups to go one sample at a time by pouring one soil type into the funnel on top of the paper. Hold the funnel over the empty cup.  Have one student prepare the timer or stopwatch to begin recording once the water begins to pour from the cup  Another student is to slowly pour 1 cup of water over the soil.  The students should observe what happens and stop the timer once the water stops dripping from the funnel.  Groups should measure the amount of water in the cup under the funnel.  Have students record the time and amount of water on their blank paper.  *\*It may be best to demonstrate this process to students to ensure they follow each step. \**  Tell students to repeat this process for all 5 soil samples.  Walk around the room during the activity to ask/answer clarifying questions and ensure students are on task.  After all groups have finished the activity, discuss the results as a class.  Ask groups if their predictions were correct.  Have students draw new conclusions about what happened based on the discussion of particle size | | Filter paper  Funnels  Cups  Sand  Clay  Silt  Topsoil  Cups of water  Printer paper  Timer or stopwatch |
| **Wrap Up,**  **Synthesis/Closure**  *13 minutes* | **Debrief/Processing (8 minutes)**  Discuss the effects that soil particle size has on the speed and retention of water.  Relate water retention and speed through soil to plants. Tell students that the type of soil plants are growing in, impacts how much water is available for the plants. As we found today:  Clay holds the most water and water does not move through it very fast. Plants must like constant access to water as well as continuous exposure to water to grow well. An example is cucumbers.  Silt holds some water, but it will dry out faster than clay. Plants in this soil like moderate amounts of water and soil that dries between waterings. An example is corn.  Topsoil is a mixture of different soils. It retains some water but also has the ability to dry out. This is a good mix for moderate water plants. An example is peppers.  Sand holds water for a short amount of time and dries out quickly. Plants in this soil like brief access to water and prefer to be dry. Two examples are carrots and desert plants.  Gravel does not hold water at all. It is mainly used in the bottom of containers as a place for water to escape the top portion of soil. It allows plants access to water through percolation (discussed in lesson 1) but keeps the roots separated from the water so they do not rot. Plants do not grow in gravel alone | |  |
| **Review & Close (3 minutes)**  Students will be asked to recap the lesson for the group  One student will provide the process of the first activity and another will explain the greater meaning.  Repeat this process for the second activity.  The instructor will tie the lesson into the greater objective of the unit for review and close the session | |  |
|  | **3-2-1 Notecards (2 minutes)**  Post assessment 3-2-1 notecards:  Side 1: 3 things the student learned  Side 2: 2 things that were interesting and 1 question the student still has | | Notecards (1 per student)  Pencils (1 per student) |
|  | | | |
| **Resources:**  This site has a great photo comparing overwatering and underwatering of the same plant: <https://www.binleyflorist.com/index.php/news/gardening-tips/216-overwatered-houseplants-fixing-the-damage> | | | |

| **Lesson 4: *Homegrown Food*** | | | |
| --- | --- | --- | --- |
| **Est. Time:** 50 minutes | | | |
| **Lesson Learning Goals/Objectives:**   1. Assess plant growth problems and formulate recommendations for improved growing quality based on evidence of soil and water conditions. 2. Identify solutions to commonly seen soil and water problems for plant development | | **Indiana Department of Education Standards**  **IAFNR-4.2** Prepare and implement plant management strategies that address environmental factors, essential nutrients, and soil management practices for productive plant growth  **EA-3.1** Understand basic needs of plant growth from germination to soil fertility | |
| **Assessments**  **Formative:**  Questions and Observation, “Homegrown Foods” worksheet article and “Save Sam’s Garden” activity | | | |
| **Concept Prerequisites or Background Knowledge Needed:**  Lesson 1 - 3 content | | | |
| **Vocabulary:**  memorandum, percolation | | | |
| **Materials & Technology Needed:**  Lesson 4 article  Lesson 4 memo  Lesson 4 supplemental materials | | | |
| **Before Lesson Preparation**  The instructor needs to print off the Lesson 4 article, memorandum, and supplemental materials such that each student receives 1 copy | | | |
|  | | | |
| **Lesson Component** | **Instructions** | | **Materials** |
| **Introduction**  *2 minutes* | Provide objectives and overview of the lesson. | |  |
| **Instructional Activities**  *40 minutes* | **Homegrown Food & Save Sam’s Garden Activity**  Briefly recap what the students have learned thus far as a Junior Soil Scientist.   * Soil particle size * Percolation * Water and Soil pH * Interactions of water and soil   Tell students that they will be using all this information today to help solve a problem related to vegetable plant growth. We will first gather all the information, and then work in teams to develop a solution.  Remind students there is no “one right answer,” and teams should be creative using the knowledge they have.  Divide students into small groups of 2 or 3  Give students the “Homegrown Food” article.  Have them read as a class or within the group.  After they are finished reading, individually answer the questions at the bottom of the article. Share within groups once finished.  After answering questions, provide students with the “Memorandum” page and the remaining supplemental materials.  Allow groups to read the memorandum and ask questions as they arise. Encourage students to refer back to the memorandum information and their prior knowledge.  Have students work as a group on the three parts of the problem listed in the memorandum.  Pause after groups have read their tasks to clarify any unclear instructions and explain the figures and tables as needed.  Have students resume working as groups. Walk around the room to answer questions by leading students to the answers within the materials without providing the direct answers.  As groups finish developing their solutions, have them share with you, or the entire class, what they intend to do to save Sam’s garden | | Lesson 4 article  Lesson 4 memo  Lesson 4 supplemental materials |
| **Wrap Up,**  **Synthesis/Closure**  *3 minutes* | Students will be asked to recap the soil science knowledge they used to develop a solution to the garden problem.  The instructor will tie the lesson into the greater objective of the unit for review and close the session | |  |
|  | | | |
| **Resources:** | | | |

| **Lesson 5: *Terrarium Construction*** | | | |
| --- | --- | --- | --- |
| **Est. Time:** 50 minutes | | | |
| **Lesson Learning Goals/Objectives:**   1. Explain a prototype design of a plant environment based on scientific evidence to optimize plant efficiency | | **Indiana Department of Education Standards**  **3-5.E.1** Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost**.**  **EA-3.1** Understand basic needs of plant growth from germination to soil fertility | |
| **Assessments**  **Formative:**  Think-Pair-Share  **Summative:**  Student project presentations, multiple-choice, matching post-test | | | |
| **Concept Prerequisites or Background Knowledge Needed:**  Lessons 1-4 content | | | |
| **Vocabulary:**  percolation, terrarium, constraints, horticulture | | | |
| **Materials & Technology Needed:**  Lesson 5 Terrarium Soil Materials handout  Lesson 5 Plant Materials/Container Materials handout  Gravel  Sand  Silt  Clay  Spinach plants  Rosemary plants  Small 3” square plastic pots  Medium 5” square plastic pots  Large 8” circle plastic pots | | | |
| **Before Lesson Preparation**  The instructor needs to print out the Lesson 5 Terrarium Soil Materials handout and the Lesson 5 Plant Materials/Container Materials handout such that each student receives one copy.  The instructor should lay out the material options on the counter before the lesson begins | | | |
|  | | | |
| **Lesson Component** | **Instructions** | | **Materials** |
| **Introduction**  *7 minutes* | Provide lesson objectives and overview  The instructor will begin the lesson by recapping lessons 1-4 and reviewing the key concepts of each lesson that are crucial for a Soil Scientist.   * Soil particle size * Percolation * Water and Soil pH * Interactions of water and soil   Describe the Engineering Design Process. Include key components of the process. Tell students they will be following the design process while creating a homegrown garden terrarium.  Explain that the terrarium is one type of homegrown gardening method where students will take home the terrarium and grow food in their window sills  **Think-Pair-Share (2 minutes)**  Ask students:  As a Junior Soil Scientist, what are some important factors I should consider when designing a plant environment? Think about your answer, discuss your answers with the person sitting next to you, and then we will share our answers with the class | |  |
| **Instructional Activities**  *30 minutes* | **Terrarium Activity (20 Minutes)**  Tell students the terrarium design activity that is very similar to a job that an urban soil scientist does when they design the optimal environment for small urban spaces such as landscaping, flowerpots, or urban gardens.  Hand out the soil materials sheet and plant materials/container materials sheet. Students will use these for their design.  Briefly go through these handouts with students.  Tell them to use all the knowledge they have gained and these sheets to design a terrarium with the optimal growing environment for their plant. Their constraints are the available plants (selection), containers (size), and soil types. There is no constraint of cost.  Students will present their final product prototype design of a plant environment after completion. They need to include scientific evidence on why their design optimizes plant efficiency  Recommend students to select their plant first and build their design from there. Only one plant and one container per person.  Scrap paper, rulers, and markers are available if they would like to draw out their design first.  Allow students time to design and build their terrariums | | Lesson 5 Terrarium Soil Materials handout  Lesson 5 Plant Materials/Container Materials handout  Gravel  Sand  Silt  Clay  Spinach plants  Rosemary plants  Small 3” square plastic pots  Medium 5” square plastic pots  Large 8” circle plastic pots  Scrap paper  Markers  Rulers |
| **Terrarium Design Presentations (Summative Assessment) (10 Minutes)**  Students will briefly present their final product prototype design of their plant environment after completion. They need to include scientific evidence on why their design optimizes plant efficiency | | Summative Assessment Presentation Rubric |
| **Wrap Up,**  **Synthesis/Closure**  *8 minutes* | **Review & Close (3 Minutes)**  The instructor begins a discussion about the activity and asks questions to ensure the desired learning outcome/objective was achieved.  Constraints  Project creation  Design process  Keeping their plant alive  The instructor asks students about additional plants they could grow at home and ties in how this practice is used to grow plants for different purposes such as feeding families.  The instructor will then close out the unit by asking students to recap each of the 5 lessons and their importance to horticulture | |  |
| **Summative Assessment Post-Test (5 minutes)**  Have students complete the summative assessment post-test before leaving to assess knowledge gained.  After completion, give students an achievement certificate for becoming a Junior Soil Scientist. | | Summative Assessment Post-test  Achievement certificate |
|  | | | |
| **Resources:** | | | |

**Supplemental Handouts & Worksheets**

Lesson numbers are labeled in the upper left hand corner of each new lesson handout

# 

# Homegrown Gardening Through the Lens of Soil Science

Summative Assessments: Knowledge Outcomes

**Pre-Test and Post-Test**

**Target Audience:** Upper Elementary School Students (grade 5) participating in *Homegrown Gardening Through the Lens of Soil Science* mini-unit as a pre-test and post-test

**Objectives:**

1. Analyze the characteristic differences between the soil types of sand, silt, and clay.
2. Categorize pH values as acidic or basic.
3. Describe the differences in acids and bases and their relation to soil quality.
4. Explain the chemistry of capillary action within soil.

**Instructions:** Complete the following questions by selecting the best answer to reflect your knowledge of soil science and its impacts on plant growth. If you get stuck on a word or have a question, raise your hand and the instructor will help you. Good luck!

**Total Points:** 25

**Summative Assessment for Knowledge Outcomes:**

**Pre/Post Test**

Students will be asked questions at the beginning of Lesson 1 to gage what they know about soil particle size, capillary action, soil pH, percolation, reactions of acids and bases, water flow, and plant growth problems. At the conclusion of Lesson 5, students will be asked these same questions again. Volunteers will then share with the group some of the ways they have grown through their participation in the unit. These questions include multiple-choice, true or false, and matching formats.

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Pre/Post-Test Questions**

*Complete the following questions by selecting the best answer to reflect your knowledge of soil science and its impacts on plant growth. If you get stuck on a word or have a question, raise your hand and the instructor will help you. Good luck!*

1. What is percolation? (2 points)
   1. Moving and filtering fluids through porous material
   2. Fluids being blocked from flowing
   3. Moving fluids through water
   4. Filtering out rocks and material from liquids
2. Which of the following soil types will water flow through the fastest? (2 points)
   1. Silt
   2. Sand
   3. Gravel
   4. Clay
3. What is capillary action? (2 points)
   1. The action of water flowing with gravity out of soil
   2. The ability of plant capillaries to turn toward the sun without assistance or limitation of gravity
   3. The action of solids to block liquids from flowing within soil
   4. The ability of a liquid to flow through narrow spaces without assistance or limitation of gravity
4. Which of the following is an acidic pH? (1 point)
   1. 3.0
   2. 9.0

True or False (2 points each)

1. True or False A pH greater than 7 is basic.
2. True or False The alkaline scale measures how acidic or basic a solution is.
3. True or False Sandy soil holds water well.
4. True or False Plants use capillary action to move water up to the leaves.
5. True or False Add limestone to soil to increase the pH.

Match the following soil types to their correct descriptions. (2 points)

1. \_\_\_\_\_\_ Gravel A. small particle size, retains water for long periods
2. \_\_\_**\_\_**  Silt B. used as a bottom layer to keep water away from plant roots
3. \_\_\_\_\_\_\_ Sand C. good for plants that like dry conditions such as desert plants
4. \_\_\_\_\_\_\_ Clay D. medium particle size, holds moisture but dries out over time

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Pre/Post-Test Questions ANSWER KEY**

*Complete the following questions by selecting the best answer to reflect your knowledge of soil science and its impacts on plant growth. If you get stuck on a word or have a question, raise your hand and the instructor will help you. Good luck!*

1. What is percolation? (2 points)
   1. **Moving and filtering fluids through porous material**
   2. Fluids being blocked from flowing
   3. Moving fluids through water
   4. Filtering out rocks and material from liquids
2. Which of the following soil types will water flow through the fastest? (2 points)
   1. Silt
   2. Sand
   3. **Gravel**
   4. Clay
3. What is capillary action? (2 points)
   1. The action of water flowing with gravity out of soil
   2. The ability of plant capillaries to turn toward the sun without assistance or limitation of gravity
   3. The action of solids to block liquids from flowing within soil
   4. **The ability of a liquid to flow through narrow spaces without assistance or limitation of gravity**
4. Which of the following is an acidic pH? (1 point)
   1. **3.0**
   2. 9.0

True or False (2 points each)

1. **True** or False A pH greater than 7 is basic.
2. True or **False** The alkaline scale measures how acidic or basic a solution is.
3. True or **False** Sandy soil holds water well.
4. **True** or False Plants use capillary action to move water up to the leaves.
5. **True** or False Add limestone to soil to increase the pH.

Match the following soil types to their correct descriptions. (2 points)

1. \_\_\_**B.**\_\_\_ Gravel A. small particle size, retains water for long periods
2. \_\_\_**D.\_\_**  Silt B. used as a bottom layer to keep water away from plant roots
3. \_\_\_**C.**\_\_\_\_ Sand C. good for plants that like dry conditions such as desert plants

\_\_\_**A.**\_\_\_ Clay D. medium particle size, holds moisture but dries out over time

# Homegrown Gardening Through the Lens of Soil Science

Summative Assessments: Performance-based Outcomes

**Presentation of Terrarium Product Rubric**

**Target Audience:** Upper Elementary School Students (grade 5) participating in *Homegrown Gardening Through the Lens of Soil Science* mini-unit who are presenting their terrarium design product during the final lesson

**Objectives:**

1. Determine the proper environment for optimal plant growth in different settings.
2. Describe the application of the engineering design process in a soil science setting.
3. Explain a prototype design of a plant environment based on scientific evidence to optimize plan efficiency.

**Instructions:**

**Large Group Share of the Final Product**

After finishing the construction of your terrarium, you will present your completed terrariums to the group describing how the terrarium optimizes plant growth efficiency. During the presentation, you should discuss the engineering design process and each step of the process you used to create your terrarium. It is important to include any constraints you faced and how you overcame them. The background knowledge you have gained during the entire unit will come in handy for this presentation. Use this information to explain why you chose the materials that you did, especially focusing on the soil type(s) and soil pH. It is important for you to use convincing and appropriate language with the correct terminology. You have worked hard throughout this unit and you should be proud of your terrarium products!

This assessment will allow the instructor to gauge how well the students retained knowledge from the unit as a whole.

**Total Points:** 20

Terrarium Product Presentation Rubric

| **Criteria** | **Poor**  **(0-1 points)** | **Adequate**  **(2-3 points)** | **Excellent**  **(4-5 points)** | **Score** |  |
| --- | --- | --- | --- | --- | --- |
|  |
| **Discusses the engineering design process used for terrarium construction** | Discusses no constraints that were faced  Or  How they were overcome | Discusses a few constraints  And  How they were overcome | Discusses all constraints that were faced  And  How they chose to overcome the constraints during terrarium design process and construction | /5 |  |
| **Demonstrates background knowledge and uses correct terminology during explanation** | Does not demonstrate a background knowledge of components to plant growth  Or  Does not use any horticulture or soil science terms  Or  Uses multiple terms incorrectly | Demonstrates a background knowledge of components to plant growth  And  Uses 1-2 horticulture or soil science terms correctly  Or  Uses more than 1 horticulture or soil science term incorrectly | Demonstrates a background knowledge of components to plant growth  And  Uses more than three horticulture or soil science terms correctly in the explanation | /5 | ////5 |
| **Explains soil type selection and an understanding of pH adjustments** | Does not explain why soil type was selected and why the soil type is appropriate  And  Does not state why (if any) adjustments were made to soil pH | Explains why soil type was selected and why the soil type is appropriate  Or  States why (if any) adjustments were made to soil pH | Explains why soil type was selected and why the soil type is appropriate  And  States why (if any) adjustments were made to soil pH | /5 |  |
| **Clearly articulates how the terrarium optimizes plant growth efficiency and uses convincing language** | Does not clearly articulate how the terrarium optimizes plant growth efficiency  And  Uses no convincing and clear language | Does not clearly articulates how the terrarium optimizes plant growth efficiency  Or  Uses no convincing and clear language | Clearly articulates how the terrarium optimizes plant growth efficiency  And  Uses convincing and clear language | /5 |  |

**Total: /20**

Lesson 1 L1: Investigating Soil as a Soil Scientist

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Draw the effects of capillary action on a plant!

Under “Capillary Action”, draw a picture that shows capillary action of water happening near plant roots in the soil. Under “No Capillary Action”, draw a picture that shows no capillary action of water happening near plant roots.

Include and label: **water**, **soil**, and a **plant**.

| Capillary Action | No Capillary Action |
| --- | --- |
|  |  |

Soil Particles Exploration

Pre-Activity Question:

Under the photos below, number the soil types (1-3) by size of particle. Number 1 being the soil with the smallest particle size and 3 being the soil with the largest particle size.

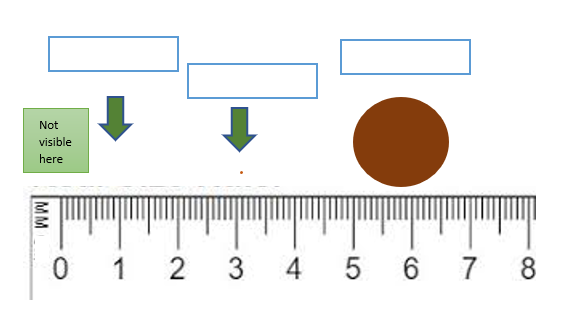
| **Sand** | **Silt** | **Clay** |
| --- | --- | --- |
|  |  |  |
| **Rank:** | **Rank:** | **Rank:** |

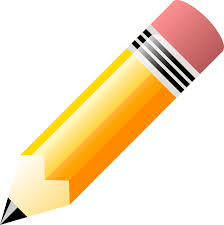
Photos retrieved from: <https://geology-fundamentals.fandom.com/wiki/4246465/soil-types>

Complete the table with your observations during the soil particle exploration activity.

| **Soil Type** | **Notes** | **Order of Settling in the Water** | **Appearance: Cloudy vs. Clear Water** |
| --- | --- | --- | --- |
| **Sand** |  |  |  |
| **Silt** |  |  |  |
| **Clay** |  |  |  |

Fill in the blank boxes of this picture identifying the particles: sand, silt, and clay.





**To help visualize the size:**

**The tip of a pencil is about 1 mm wide!**

Lesson 2

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_

*Fill in the chart below with your observations from the pH Paper Test results.*

pH Paper Test Activity

| Solution | Test Result Color | Test Result pH |
| --- | --- | --- |
| Saltwater |  |  |
| Pond Water |  |  |
| Tap Water |  |  |
| Filtered Water |  |  |
| Vinegar & Water |  |  |
| Baking Soda & Water |  |  |

*Answer the following questions as a group after completing each station. Think through all the information we have just learned to answer the questions!*

Which sample was most basic? How do you know this?

Which sample was most acidic? How could you tell this?

Lesson 4

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_

*Read the article and complete the questions that follow to the best of your ability. After completing the article and questions, continue on by reading the Memorandum.*

Homegrown Food

Many people have found creative ways to grow their own food from home even with limited outdoor space. Some have small gardens in their yard or build raised beds. Others create window box planters that sit outside apartment windows or have small potted plants that sit inside window sills. Homegrown food is especially useful during times of crisis, food shortages, or limited access to fresh vegetables. It can provide families with diverse, healthy food options to supplement the items they buy at the grocery store. 

Vegetable plants are not all the same, and they require varying levels of attention and care. For optimal growth, they need specific soil compositions, water amounts, light intensities, spacing between plants, and growing temperatures. It is important to read the instructions on the seed or plant packages before planting to prevent the plants from dying at a young age.

After planting, it is necessary to monitor the plants daily. The plants will show signs that something is wrong by wilting, changing colors, or not growing. If this happens, the person needs to look back at the plant labels and examine each characteristic. There are soil sample tests available to measure the soil type and pH. If the soil type is not correct, it may be necessary to move the plant to a new location. Soil pH can be altered by adding limestone or sulfur depending on if the pH needs to be raised or lowered. If the plant is receiving the incorrect amount of water, it is easy to increase or decrease the number of watering’s per week. Nearby water sources or frequent rains may alter the amount of water needed. Shaded areas caused by trees or fences can stunt vegetable plant growth leading to less productive plants. These are just a few examples of common issues seen when growing vegetables at home. If the condition of the plants continues to decline, the grower may need to contact a plant expert at a nearby garden center or county Extension office.

*What challenges do you see with growing your own food?*

*Imagine growing your own vegetables in a garden. If you notice that your vegetable plants are not growing, what factors would you look at when developing a plan to save the plants from dying? Explain why you chose each factor.*

**MEMORANDUM**

**To:** Junior Soil Scientists

**From:** Jillian Wilder Purdue Cooperative Extension Service

**Subject:** Save Sam’s Vegetable Garden

Homegrown vegetable gardens are becoming more popular as a new hobby or as a source of fresh vegetables for families with limited access to food. When growers have questions about their plants that are not growing properly, they reach out to their local Extension Educator.

Sam, a first time vegetable grower, has contacted us because several plants in his garden are dying. He has provided a drawing of his garden which is labeled as **Figure 1**. The garden has been divided into four sections which are labeled in the drawing. Each plant image represents one plant. Within this picture you can see there is an (**!**)symbol next to each plant that is dying.

Sam knows that he is providing the correct amount of light and space for each plant to grow, so we can eliminate these factors from our investigation. Next, we want to look at the soil and amount of water each plant is exposed to. We have decided to complete a soil sample test on each section of the garden measuring the soil type and pH. The results of this test are in **Table 1**. Sam waters his garden two times a week.

I need your help to interpret the data and develop a solution to save Sam’s plants! **Table 2** is a resource for you to use with the soil and water characteristics needed by common vegetables.

**Here is what I need you to do:**

1. Figure out what is wrong with each of Sam’s dying plants. List these on the next page.

1. Develop a plan to save the plants. Provide your plan for each plant type on the next page. Consider the cost of each action by looking at **Table 3**.
2. Use **Table 3** to calculate the total cost of saving all of Sam’s dying plants. Justify the amounts you spent.

Thank you,

Jillian Wilder

1. List what is wrong with each of Sam’s dying plants.

**Section 1: Peas**

**Section 2: Broccoli**

**Section 3: Green beans**

**Section 4: Carrots**

1. What are you going to do to save each plant? Provide your plan here. Consider the cost of each action by looking at **Table 3.**

**Section 1: Peas**

**Section 2: Broccoli**

**Section 3: Green beans**

**Section 4: Carrots**

1. Calculate the cost of saving the plants below.

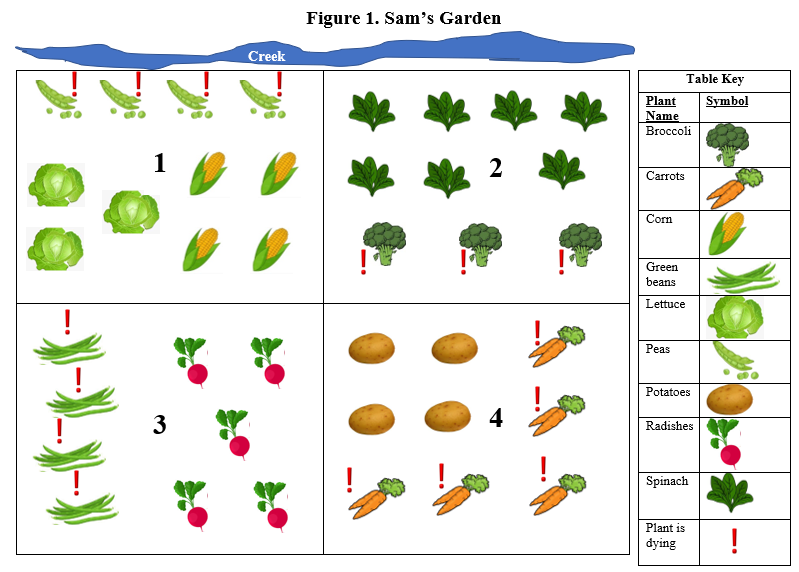
Section 1: Peas = \_\_\_\_\_\_

Section 2: Broccoli = \_\_\_\_\_\_

Section 3: Green beans = \_\_\_\_\_\_

Section 4: Carrots = **\_\_\_\_\_\_**

**Total Cost = \_\_\_\_\_\_**



**Table 1. Soil Sample Test Results**

| Garden Section Number | Soil Type | Soil pH |
| --- | --- | --- |
| 1 | Silt | 6.8 |
| 2 | Silt Clay Mixture | 7.0 |
| 3 | Sand Silt Mixture | 6.9 |
| 4 | Sand | 5.4 |

**Table 2. Plant Soil and Water Data**

| Plant | Desired Soil Type | Suitable Soil pH Ranges | Desired Number of Watering  (per week) |
| --- | --- | --- | --- |
| Broccoli | Sand | 6.0 – 7.0 | 1-2 times |
| Carrots | Sand | 5.6 – 7.0 | 1-2 times |
| Corn | Silt | 5.5 – 7.0 | 3-4 times |
| Cucumbers | Silt clay mixture | 5.5 – 6.7 | 1 time |
| Green Beans | Silt clay mixture | 5.5 – 6.5 | 2 times |
| Lettuce | silt | 6.0 – 7.0 | 2-3 times |
| Onions | Sand silt mixture | 6.0 – 6.25 | 1 time |
| Peas | Silt | 6.0 – 7.0 | 0-1 time |
| Peppers (Bell) | Sand silt mixture | 5.5 – 6.5 | 2-3 times |
| Potatoes | Sand | 5.0 – 5.4 | 1-2 times |
| Radishes | Sand silt mixture | 6.5 – 7.0 | 2-3 times |
| Spinach | Silt clay mixture | 6.0 – 7.0 | 2-3 times |
| Tomatoes | Silt | 5.5 – 6.75 | 2 times |

**Table 3. Plant Care Costs Table**

| Plant Care Action | Notes | Cost (per plant) |
| --- | --- | --- |
| Transplanting  (moving a dying plant to a new location) | No guarantee the plant will recover from its current state | **$0.50** |
| Plant New Seeds | This will delay harvest by 3 weeks | **$0.60** |
| Change Number of Times for Watering each Week | Decrease or increase the number of times plants receive water | **Free** |
| Add Limestone | Increases the pH | **$0.40** |
| Add Sulfur | Decrease the pH | **$0.40** |

| Soil Type | Pros | Cons | Soil Properties | Soil pH |
| --- | --- | --- | --- | --- |
| Gravel | * Large spaces between particles are good for water flow or large root growth * As a layer, it holds water well in the bottom of undrainable containers to prevent roots from rotting | * Does not retain water * Rigid structure is not suitable for most plants as sole growing material | * Permeability * Large particle size * Coarse soil | 7.1 |
| Sand | * Good growing environment for plants that prefer very dry conditions * Adequate space between particles for air movement and root growth | * Dries out quickly * Does not hold together well | * Porosity * Large particle size * Coarse soil | 6.8 |
| Silt | * Holds in moisture but will dry out after a few days * Keeps shape well and does not fall apart | * If packed together, it can compress and restrict root growth * Expensive | * High density * Medium particle size * Fine soil | 7.0 |
| Clay | * Retains water for extended periods of time * Does not dry out quickly | * Clumps together easily preventing root growth      * Does not drain well and can hold too much water for some plants | * High cohesion * Compressibility * Small particle size * Fine soil | 7.0 |

**Lesson 5 Terrarium Soil Materials**

**Plant Materials** (choose 1)

| Plant type | Uses | Water Requirements | Mature Plant Size | Desired Soil pH |
| --- | --- | --- | --- | --- |
| Spinach | * Salads, sandwich toppings, cooked in pastas | * Prefers continually moist soil * Do not let soil dry between watering * Water regularly when soil is slightly damp to the touch | * Is ready to eat when leaves are around 6” long | 7.0 |
| Rosemary | * Seasoning in soup, meats, and salads * Flavoring in teas | * Prefers well-drained soil * Let soil dry between watering * Water thoroughly when soil is dry to the touch | * Can grow up to 36” but can be trimmed to limit growth | 6.9 |

**Container Materials** (choose 1)

| Container | Length | Width (square pots)  Diameter (circle pots) | Height |
| --- | --- | --- | --- |
| Small  (3” square pot) | 3” | 3” | 3” |
| Medium  (5” square pot) | 5” | 5” | 5” |
| Large  (8” circle pot) | -- | 8” | 7” |



Lesson 1 Investigating Soil as a Soil Scientist

Name: \_\_Sally Jo\_\_\_\_\_\_ Date: \_\_4/2/2020\_\_\_\_\_\_

Draw the effects of capillary action on a plant!

Under “Capillary Action”, draw a picture that shows capillary action of water happening near plant roots in the soil. Under “No Capillary Action”, draw a picture that shows no capillary action of water happening near plant roots.

Include and label: **water**, **soil**, and a **plant**.

| Capillary Action | No Capillary Action |
| --- | --- |
| Soil Clipart Seedling Simple Plant With Roots Transparent - Plant ... | C:\Users\Brooke\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\BDE9AA42.tmp |

Soil Particles Exploration

Pre-Activity Question:

Under the photos below, number the soil types (1-3) by size of particle. Number 1 being the soil with the smallest particle size and 3 being the soil with the largest particle size.

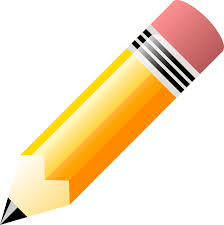
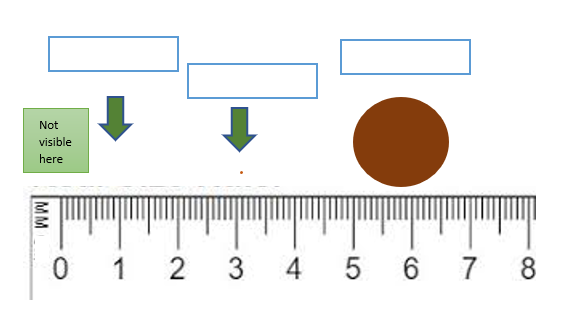
| **Sand** | **Silt** | **Clay** |
| --- | --- | --- |
|  |  |  |
| **Rank: 3** | **Rank: 2** | **Rank: 1** |

Photos retrieved from: <https://geology-fundamentals.fandom.com/wiki/4246465/soil-types>

Complete the table with your observations during the soil particle exploration activity.

| **Soil Type** | **Notes** | **Order of Settling in the Water** | **Appearance: Cloudy vs. Clear Water** |
| --- | --- | --- | --- |
| **Sand** | Very quickly went to the bottom of the jar, rough texture, can see individual pieces of sand | Settled out first | Clear |
| **Silt** | Took longer to reach the bottom, dark color, feels smoother than sand | Settled out second | Slightly cloudy |
| **Clay** | Stayed suspended in the water, took a very long time to reach the bottom, smoothest texture | Settled out third | Very cloudy |

Fill in the blank boxes of this picture identifying the particles: sand, silt, and clay.



**To help visualize the size:**

**the tip of a pencil is about 1 mm wide!**



Lesson 2

Name: \_\_\_Sally Jo\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_4/3/2020\_\_\_\_\_\_

*Fill in the chart below with your observations from the pH Paper Test results.*

pH Paper Test Activity

| Solution | Test Result Color | Test Result pH |
| --- | --- | --- |
| Saltwater | Deep Green | 8.2 |
| Pond Water | Light Green | 7.6 |
| Tap Water | Light Green | 7.4 |
| Filtered Water | Between Light Green and Yellow | 7.0 |
| Vinegar & Water  (50/50 mixture) | Bright Orange | 2.6 |
| Baking Soda & Water | Greenish Blue | 8.8 |

*Answer the following questions as a group after completing each station. Think through all the information we have just learned to answer the questions!*

Which sample was most basic? How do you know this?

The baking soda and water sample was the most basic. We know this because the color of the pH paper was the closest to blue and the pH value was higher than all the other values at 8,8. In the pH paper test kit, the pH key shows that the higher pH values turn the paper very blue. High pH values are basic.

Which sample was most acidic? How could you tell this?

The vinegar and water sample was the most acidic. We know that it had a bright orange color with a pH of 2.6. This pH was the lowest of all the samples. The pH paper key shows us that the closer the color is to red, the more acidic the solution is. A low pH value means the sample is acidic.

Lesson 4

Name: \_\_Sally Jo\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_4/5/2020\_\_\_\_\_

*Read the article and complete the questions that follow to the best of your ability. After completing the article and questions, continue on by reading the Memorandum.*

Homegrown Food

Many people have found creative ways to grow their own food from home even with limited outdoor space. Some have small gardens in their yard or build raised beds. Others create window box planters that sit outside apartment windows or have small potted plants that sit inside window sills. Homegrown food is especially useful during times of crisis, food shortages, or limited access to fresh vegetables. It can provide families with diverse, healthy food options to supplement the items they buy at the grocery store. 

Vegetable plants are not all the same, and they require varying levels of attention and care. For optimal growth, they need specific soil compositions, water amounts, light intensities, spacing between plants, and growing temperatures. It is important to read the instructions on the seed or plant packages before planting to prevent the plants from dying at a young age.

After planting, it is necessary to monitor the plants daily. The plants will show signs that something is wrong by wilting, changing colors, or not growing. If this happens, the person needs to look back at the plant labels and examine each characteristic. There are soil sample tests available to measure the soil type and pH. If the soil type is not correct, it may be necessary to move the plant to a new location. Soil pH can be altered by adding limestone or sulfur depending on if the pH needs to be raised or lowered. If the plant is receiving the incorrect amount of water, it is easy to increase or decrease the number of watering’s per week. Nearby water sources or frequent rains may alter the amount of water needed. Shaded areas caused by trees or fences can stunt vegetable plant growth leading to less productive plants. These are just a few examples of common issues seen when growing vegetables at home. If the condition of the plants continues to decline, the grower may need to contact a plant expert at a nearby garden center or county Extension office.

*What challenges do you see with growing your own food?*

Some challenges that I see with growing my own food is choosing the right place to grow the plants. Our home has limited space for plants, and it may be difficult to have plants grow there. Also, I see challenges in ensuring the soil type, soil pH, light level, water amounts, and spacing for the different kinds of vegetables are correct. They all have different needs, so it is important to read the labels!

*Imagine growing your own vegetables in a garden. If you notice that your vegetable plants are not growing, what factors would you look at when developing a plan to save the plants from dying? Explain why you chose each factor.*

I would look at soil, water, and sunlight. Plants need specific soil types to grow correctly. If a plant is getting too much or too little water, they will not grow correctly. A plant needs a certain amount of sunlight, so I would check if anything is blocking the sun from reaching the plant.

**MEMORANDUM**



**To:** Junior Soil Scientists

**From:** Jillian Wilder Purdue Cooperative Extension Service

**Subject:** Save Sam’s Vegetable Garden

Homegrown vegetable gardens are becoming more popular as a new hobby or as a source of fresh vegetables for families with limited access to food. When growers have questions about their plants that are not growing properly, they reach out to their local Extension Educator.

Sam, a first time vegetable grower, has contacted us because several plants in his garden are dying. He has provided a drawing of his garden which is labeled as **Figure 1**. The garden has been divided into four sections which are labeled in the drawing. Each plant image represents one plant. Within this picture you can see there is an (**!**)symbol next to each plant that is dying.

Sam knows that he is providing the correct amount of light and space for each plant to grow, so we can eliminate these factors from our investigation. Next, we want to look at the soil and amount of water each plant is exposed to. We have decided to complete a soil sample test on each section of the garden measuring the soil type and pH. The results of this test are in **Table 1**. Sam waters his garden two times a week.

I need your help to interpret the data and develop a solution to save Sam’s plants! Table 2 is a resource for you to use with the soil and water characteristics needed by common vegetables.

**Here is what I need you to do:**

1. Figure out what is wrong with each of Sam’s dying plants. List these on the next page.

1. Develop a plan to save the plants. Provide your plan for each plant type on the next page. Consider the cost of each action by looking at **Table 3**.
2. Use **Table 3** to calculate the total cost of saving all of Sam’s dying plants. Justify the amounts you spent.

Thank you,

Jillian Wilder

1. List what is wrong with each of Sam’s dying plants.

**Section 1: Peas**

Peas are receiving too much water. Sam is overwatering them two times a week when they should get water one time a week. They are also getting some water from the creek nearby.

**Section 2: Broccoli**

Broccoli needs sandy soil, not the silt clay mixture found in section 2.

**Section 3: Green beans**

Green beans need silt clay soil not the silt sand soil they are in. Also, the pH is too high for green beans.

**Section 4: Carrots**

The soil pH is too high. Carrots need a higher pH than 5.4.

1. What are you going to do to save each plant? Provide your plan here. Consider the cost of each action by looking at **Table 3**

**Section 1: Peas**

Change the number of times the peas get watered each week. They may be receiving enough water from the creek. If they seem to need more water, only water once per week.

**Section 2: Broccoli**

One option is to transplant the broccoli to section 3 where there are higher concentrations of sandy soil. The green beans can then move to section 2.

**Section 3: Green beans**

Green beans can be transplanted to section 2. Also, the pH of section 2 needs to be decreased where the green beans are planted. Add sulfur near these plants.

**Section 4: Carrots**

The pH is too low in section 4 for carrots. Add limestone by these plants to increase the pH.

1. Calculate the cost of saving the plants below.

Section 1: Peas = \_$0.00\_\_\_

Section 2: Broccoli = \_$1.50\_\_\_\_\_

3 broccoli plants x & 0.50 transplant fee = $1.50

Section 3: Green beans = \_$3.60\_\_\_\_\_

4 green bean plants x $0.50 transplant fee = $2.00

4 green bean plants x $0.40 add sulfur fee = $1.60

Section 4: Carrots = **\_**$2.00**\_\_\_\_\_**

5 carrot plants x $0.40 add limestone fee = $2.00

**Total Cost = \_\_$7.10\_\_\_\_ (**This is just one example of options for action.)