Thinking Inside the Box: Designing Plant Packages
An integrated lesson plan on technology, engineering, science, and mathematics for 4th grade.

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(Team 5)

Virginia Tech, Blacksburg, VA
Fall Semester 2009

Abstract:
The goal of this integrative unit is to develop an understanding of the interrelationship of technology/engineering with science and mathematics. The original structure of this unit is adapted from the Engineering is Elementary, Thinking Inside the Box; Designing plant packages curriculum. The original unit contained technology, engineering, and science interrelationships; the mathematics component in the unit was weak. This revised unit has been correlated with the Virginia Standards of Learning to specifically address fourth grade science and mathematics SOLs. Special attention in developing an additional third mini-lesson within lesson three added the component of measuring mass, weight, volume and postal costs of shipping. The SOL strands of measurement, life processes, and living systems are areas of concern for fourth grade students in Virginia. This unit now intentionally teaches both of these areas within the context of an engineering design challenge.

On teaching this unit:
There are three main best practices strategies that have been inculcated into this unit that lend themselves to inquiry-based learning and Integrative STEM education teaching pedagogy. Because students do not always come to class having a wealth of science or math background knowledge, teachers need to provide opportunities for their students to gain the necessary background knowledge to be successful in each lesson.

Since all students do not learn in the same way or at the same rate, teachers need use as many different modalities as they can to ensure students are exposed to information in multiple ways. An excellent way to build background knowledge and tap into multiple modalities is through the use of a PowerPoint for concept scaffolding. This lesson uses concept scaffolding by having students first view a PowerPoint presentation on measurement of volume, mass, and weight. PowerPoints are great for scaffolding because they tap into several modalities via rich pictorial representations, oral listening skills, and reading skills through a progression of concepts; one building directly upon the other. The measurement PowerPoint begins with lower level knowledge acquisitions, which is then applied to measuring volume and weight, which then unfolds into the application of package plans for the overall team project.

This unit also uses an iterative process to provide content scaffolding by alternating whole class discussions and small group tasks. The teacher introduces the concepts through the PowerPoint and leads the discussion to get students thinking about the topic. Students then work collaboratively to explore and apply the concepts through discovery learning. The class comes back together to analyze and synthesize learning from the small group activities. The teacher builds on that synthesis to form the background knowledge for the next concept and the cycle starts again.

Learning is a social event and it is important for teachers to build in opportunities to have students work in cooperative learning groups. This lesson builds in collaborative learning through working as a team during the package design process and measurement activities. These cooperative learning groups lend themselves to collaborative learning, for its benefits as students work in groups to measure during
the lab, participate in group discussions, and work to graph their results.

Finally, the students are engaged, explore, explain, extend, and evaluate throughout this lesson using the 5E’s Model of Inquiry, also known as discovery learning. Discovery learning was purposefully selected for this lesson because it lends itself to students working in groups to measure during the lab. It also lends itself to student discussions and students developing their own ideas for solving a set problems. The teacher becomes the facilitator as students work on the hands-on labs to measure and calculate volume and weight. Discovery learning eliminates passive learning and lecture and replaces it with students taking ownership of their own learning as they develop skills in active engagement and active learning.

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# Unit Overview

## UNIT DETAILS

<table>
<thead>
<tr>
<th>Unit Title:</th>
<th>Collaborating Authors:</th>
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</thead>
<tbody>
<tr>
<td>Thinking Inside the Box: Designing Plant Packages</td>
<td>Patricia Watson, Technology</td>
</tr>
<tr>
<td></td>
<td>Kathleen Woodington, Elem. Ed &amp; Math</td>
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<tr>
<td></td>
<td>Emily Leake, Technology</td>
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<table>
<thead>
<tr>
<th>Curriculum Area(s):</th>
<th>Grade Level:</th>
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<tbody>
<tr>
<td>Technology, Science, &amp; Mathematics</td>
<td>Elementary School: 4th grade</td>
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### Summary of Context & Challenge:

“Thinking Inside the Box” is an *Engineering is Elementary* (EiE) unit designed by the Museum of Science, Boston for third through fifth grade students. The unit is introduced by a story set in Jordan and throughout the unit students make connections to the story. The setting also allows students to explore the geography and culture of Jordan. In the unit, students use the engineering design process to design and create a package to hold a plant. Students explore package engineering and how package function must incorporate the needs of the product (a plant) and consumer. Technology/engineering is the primary discipline addressed as students learn about the field of engineering, experiment with material properties, examine the requirements and constraints of the consumer, and apply the engineering design process. Science is a secondary discipline addressed in the unit as students apply their understanding of plant structure and photosynthesis to ensure that plant needs are met. This unit has been adapted to include the fourth grade Virginia mathematics standards for measurement of weight, mass, and volume. Students will explore the trade-offs between the volume and the weight of their package as they consider the needs of the plant versus the need to make a package that is easily portable and cost efficient. Three days after students create their plant package they evaluate the plant’s health using a rubric and redesign their package. Finally, students reflect and write about their experience.

### Time Requirements:

- 5 Weeks: (10) Lessons range from 45 - 90 minutes

### Overall/Main Learning Objectives (SWBAT):

- Demonstrate knowledge of package design, function, properties, and purpose
- Apply math, science, and technology to design, create, and test a package design.
- Use basic tools and materials to construct a prototype of plant package.
- Communicate advantages and disadvantages of package material, design, and construction.
- Identify basic needs of a plant and transportation of a plant.
<table>
<thead>
<tr>
<th>Lesson Titles &amp; Descriptions *Entire Unit is DBL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Week 1:</strong> Engineering Design Process: Introduction to Package Design</td>
</tr>
<tr>
<td>Sub-Lesson #1: Introduction: A Gift From Fadil</td>
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<tr>
<td>Sub-Lesson #2: Engineering Design Process</td>
</tr>
<tr>
<td><strong>Week 2:</strong> Package Engineering</td>
</tr>
<tr>
<td><strong>Week 3:</strong> Package Design Technology &amp; Plant Life</td>
</tr>
<tr>
<td>Sub-Lesson #1: Plant Anatomy &amp; Needs</td>
</tr>
<tr>
<td>Sub-Lesson #2: Properties of Materials, Purpose &amp; Consumer Needs of Packaging</td>
</tr>
<tr>
<td>Sub-Lesson #3: Volume &amp; Mass of Packages</td>
</tr>
<tr>
<td><strong>Week 4:</strong> Package Construction</td>
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<td><strong>Week 5:</strong> Package Evaluation &amp; Analysis</td>
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</table>
**Lesson #3**

**CURRICULAR DETAILS**

<table>
<thead>
<tr>
<th>Lesson #3 Title:</th>
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<tbody>
<tr>
<td>Package Design Technology &amp; Plant Life</td>
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<table>
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<tr>
<th>Time Requirements:</th>
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<tr>
<td>Approximately 1 week, with each sub-lesson being 50-90 minutes long</td>
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<table>
<thead>
<tr>
<th>Learning Objectives (SWBAT):</th>
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<tr>
<td>Students will be able to:</td>
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<tr>
<td>• identify and explain the basic needs of a plant (Air, Light, Water, Nutrients).</td>
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<tr>
<td>• identify and explain the package functions required to meet the needs of the plant and the consumer.</td>
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<tr>
<td>• identify properties of the materials to be used in the design and evaluate how well they will meet each need of the plant and the consumer.</td>
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<tr>
<td>• brainstorm ways that the two base packages and other materials could be modified to meet the needs of the plant and the consumer.</td>
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<tr>
<td>• measure the mass and volume of a package using appropriate measuring tools provided (e.g. scale, ruler, etc).</td>
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<thead>
<tr>
<th>Assessment:</th>
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<tbody>
<tr>
<td>Students will create a Plant Health Rubric and achieve 90%.</td>
</tr>
<tr>
<td>o Identifying plant needs and determining the health of the plant.</td>
</tr>
<tr>
<td>Students will complete the Plant Evaluation and achieve 80%.</td>
</tr>
<tr>
<td>o Students will work in groups to determine if plants are healthy or not based on the rubric guidelines they made as a class. They will analyze the results to determine if the plants are receiving their basic needs.</td>
</tr>
<tr>
<td>Students will complete the Functions of Our Plant Package and achieve 80%.</td>
</tr>
<tr>
<td>o Students will work as a class to discuss and evaluate the plant package functions and consumer needs.</td>
</tr>
<tr>
<td>Verbally, students will actively participation in class discussions to determine package functions, material properties, plant needs, and consumer needs.</td>
</tr>
<tr>
<td>Students will measure the mass and volume of a package with 80% accuracy.</td>
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<thead>
<tr>
<th>Prerequisites (optional):</th>
<th>Virginia Standards of Learning (SOLs):</th>
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<tbody>
<tr>
<td>Science 2.4b</td>
<td>• Mathematics 4.6</td>
</tr>
<tr>
<td>o identify and describe changes in a plant from flower (blossom) to fruit</td>
<td>o The student will:</td>
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<tr>
<td>Mathematics 3.9</td>
<td>▪ estimate and measure weight/mass and describe the results in U.S. Customary and metric units as appropriate.</td>
</tr>
<tr>
<td>o The student will create and solve</td>
<td>▪ identify equivalent measurements between units within the U.S. Customary system (ounces, pounds, and tons) and between units within the</td>
</tr>
</tbody>
</table>
problems in context

• Mathematics 4.8
  o The student will:
    ▪ estimate and measure liquid volume and describe the results in U.S. Customary units.
    ▪ identify equivalent measurements between units within the U.S. Customary system (cups, pints, quarts, and gallons).

• Science 4.4
  o The student will investigate and understand basic plant anatomy and life processes. Key concepts include:
    ▪ the structures of typical plants (leaves, stems, roots, and flowers);
    ▪ processes and structures involved with reproduction (pollination, stamen, pistil, sepal, embryo, spore, and seed);
    ▪ photosynthesis (sunlight, chlorophyll, water, carbon dioxide, oxygen, and sugar);
    ▪ dormancy.

• Computer/Technology 3-5.7
  o The student will use technology resources for solving problems and making informed decisions.

INSTRUCTIONAL DETAILS

Suggested Materials and Resources:

• The Engineering Design Process: Five Steps for Engineering Design Guide (Reproducible 4-1 from EiE curriculum binder)

• Handout Materials:
  o Functions of Our Plant Packages (Reproducible 3-2 from EiE curriculum binder)
  o Base Packages (Reproducible 3-4 from EiE curriculum binder)
  o Plant Structure and Function
  o Plant Health Rubric (Reproducible 3-1 from EiE curriculum binder)
  o Graphing: Weight vs. Volume
  o Graphing: Weight vs. Shipping Costs
  o Our Package Plan
  o Our Engineering Design Process

• Measuring Tools: scales, rulers, etc
• Plants (for observation and package design development in weeks 4 & 5)
• Recyclables (use old boxes for sample mailing packages)
• PowerPoints:
  o Plant Health
  o Measuring Mass, Weight, & Volume
  o Calculating Volume, Weight, & Postage
• Objects for Measurement: sample packages, soil, rice, etc.
• Computers with Internet Access (for USPS shipping cost research)
**Instructional Strategies:**

- Brainstorming
- Task analysis
- Discovery learning
- Critical thinking
- Concept scaffolding
- High order thinking
- Collaborative learning (with package design teams)
- Continued development of problem based learning

**Teacher Preparations:**

- Purchase or grow plants prior to this unit.
- Provide examples of an unhealthy and healthy plants. These will aid in the discussion of plant needs and what happens to a plant when those needs are not met.
- Load PowerPoints presentations onto school network for easy access from all computers in the classroom.
- Develop picture word wall for vocabulary covered in this unit.
- Make sure students have access to the internet for research on postal pricing information they will need to research.
- Continue collecting recyclable boxes to be used by package design teams.
- Develop higher order thinking questions to guide student discussions.
**Sub-Lesson 3**

<table>
<thead>
<tr>
<th>CURRICULAR DETAILS</th>
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<tbody>
<tr>
<td><strong>Lesson Title:</strong></td>
</tr>
<tr>
<td>- Volume &amp; Mass of Packages</td>
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<tr>
<td><strong>Learning Objectives (SWBAT):</strong></td>
</tr>
<tr>
<td>Students will be able to:</td>
</tr>
<tr>
<td>- Identify the constraints for shipping a package.</td>
</tr>
<tr>
<td>- Identify trade-offs for shipping costs and volume of their plant package.</td>
</tr>
<tr>
<td>- Measure the volume of 3D object using the appropriate tools provided.</td>
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<tr>
<td>- Measure the mass of a 3D object using the appropriate tools provided.</td>
</tr>
<tr>
<td>- Use imperial and metric units to describe their measurements of weight and volume.</td>
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<tr>
<td><strong>Assessment:</strong></td>
</tr>
<tr>
<td>- Students will measure a variety of objects and determine the weight and volume of these objects with 80% accuracy as informally observed by the teacher.</td>
</tr>
<tr>
<td>- Students will use their measurements from the activity to graph their results with 80% accuracy as documented on the Graphing handouts.</td>
</tr>
<tr>
<td>- Students will convert mass and volume measurement from imperial to metric units with 80% accuracy as documented on the Graphing handouts.</td>
</tr>
<tr>
<td>- Verbally, students will actively participation in class discussions to determine weight, volume, plant needs of soil, and postal costs to mail a package based on specific weights.</td>
</tr>
<tr>
<td>- Students will compare current postal rates in their locality with weight of a package with 100% accuracy as documented on the Graphing handouts.</td>
</tr>
<tr>
<td>- Students will identify at least two trade-offs for their team's choice of package size using the handout &quot;Our Package Plan&quot;.</td>
</tr>
<tr>
<td>- Verbally, students will actively participate in class discussions about constraints for shipping packages.</td>
</tr>
<tr>
<td><strong>Prerequisites (optional):</strong></td>
</tr>
<tr>
<td>- Mathematics 3. 11</td>
</tr>
<tr>
<td>- The student will</td>
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<tr>
<td>- estimate and then use actual measuring devices with metric and U.S. customary units to measure</td>
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<tr>
<td>- liquid volume - cups, pints, quarts, gallons, and liters; and</td>
</tr>
<tr>
<td>- weight/mass - ounces, pounds, grams, and</td>
</tr>
<tr>
<td>- Virginia Standards of Learning (SOLs)</td>
</tr>
<tr>
<td>- Mathematics 4.6</td>
</tr>
<tr>
<td>- The student will:</td>
</tr>
<tr>
<td>- estimate and measure weight/mass and describe the results in U.S. Customary and metric units as appropriate.</td>
</tr>
<tr>
<td>- identify equivalent measurements between units within the U.S. Customary system (ounces, pounds, and tons) and between units within the metric system (grams and kilograms).</td>
</tr>
</tbody>
</table>
kilograms.

- **Mathematics 3.21**
  - The student, given grid paper, will
    - collect and organize data on a given topic of his/her choice using observations, measurements, surveys, or experiments; and
    - construct a line plot, picture graph, or a bar graph to represent the results. Each graph will include an appropriate title and key.

- **Mathematics 4.8**
  - The student will:
    - estimate and measure liquid volume and describe the results in U.S. Customary units.
    - identify equivalent measurements between units within the U.S. Customary system (cups, pints, quarts, and gallons) and between units within the metric system (milliliters and liters).

- **Computer/Technology 5.7**
  - The student will use technology resources for solving problems and making informed decisions.

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**INSTRUCTIONAL DETAILS**

**Suggested Materials and Resources:**

- The Engineering Design Process: Five Steps for Engineering Design Guide (for student and teacher reference) (Reproducible 4-1 from curriculum binder)
- Handout Materials:
  - Graphing: Weight vs. Volume
  - Graphing: Weight vs. Shipping Costs
  - Our Package Plan
  - Our Engineering Design Process
- PowerPoints:
  - Measuring Mass, Weight, & Volume
  - Calculating Volume, Weight, & Postage
- Measuring Tools: scales, rulers, rice, soil, etc.
- Objects for Measurement: sample packages, soil, rice, etc.
- Computers with Internet Access (for USPS shipping cost research)

**Instructional Strategies:**

- Discovery learning
- Concept scaffolding
- Collaborative learning (with package design teams)
**Teacher Preparations:**

- Load PowerPoints presentations onto school network for easy access from all computers in the classroom.
- Check to make sure all measuring devices are working properly.
- Make sure students have access to the internet for research on postal pricing information they will need to research.

**LESSON DETAILS**

<table>
<thead>
<tr>
<th>Teacher Procedure</th>
<th>Student Procedure</th>
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<tbody>
<tr>
<td><strong>Introduction:</strong> (One Class Period)</td>
<td><strong>Introduction:</strong> (One Class Period)</td>
</tr>
<tr>
<td>- The introduction will start with a group discussion. The teacher will lead the discussion with the question: <em>What if we want to mail the package?</em></td>
<td>- Students will actively participate in a group discussion regarding weight, volume, materials, plant protection, costs, and trade-offs in terms of mailing a package.</td>
</tr>
<tr>
<td>- Students will be challenged with a series of thought provoking questions during the discussion:</td>
<td>- Students brainstorm constraints of mailing a package; USPS rules and postage</td>
</tr>
<tr>
<td>- What constraints do we need to consider?</td>
<td>- Students will actively participate in a group discussion regarding weight, volume, materials, costs, and trade-offs in terms of mailing a package.</td>
</tr>
<tr>
<td>- Weight?</td>
<td>- Students will actively participate in a group discussion regarding weight, volume, materials, costs, and trade-offs in terms of mailing a package.</td>
</tr>
<tr>
<td>- Postage Rules?</td>
<td>- Students will actively participate in a group discussion regarding weight, volume, materials, costs, and trade-offs in terms of mailing a package.</td>
</tr>
<tr>
<td>- Plant Needs?</td>
<td>- Students will actively participate in a group discussion regarding weight, volume, materials, costs, and trade-offs in terms of mailing a package.</td>
</tr>
<tr>
<td>- Amount of Soil?</td>
<td>- Students will actively participate in a group discussion regarding weight, volume, materials, costs, and trade-offs in terms of mailing a package.</td>
</tr>
<tr>
<td>- Water?</td>
<td>- Students will actively participate in a group discussion regarding weight, volume, materials, costs, and trade-offs in terms of mailing a package.</td>
</tr>
<tr>
<td>- Sunlight?</td>
<td>- Students will actively participate in a group discussion regarding weight, volume, materials, costs, and trade-offs in terms of mailing a package.</td>
</tr>
<tr>
<td>- Air?</td>
<td>- Students will actively participate in a group discussion regarding weight, volume, materials, costs, and trade-offs in terms of mailing a package.</td>
</tr>
<tr>
<td>- After the discussion the teacher will present a group of boxes to the class. The boxes will vary in size and weight. Students will be asked to estimate how much they think it will cost to mail each of the packages presented.</td>
<td></td>
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<table>
<thead>
<tr>
<th><strong>Concept Development:</strong> (Two Class Period)</th>
<th><strong>Concept Development:</strong> (Two Class Periods)</th>
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<tbody>
<tr>
<td>A presentation of how to measure weight, mass, and volume will be given with regards to application of package design.</td>
<td>Watch the presentation of how to measure weight, mass and volume and how it applies to application of package design.</td>
</tr>
<tr>
<td>A review of metric units versus imperial units will be given and related to the original story (<em>A Gift From Fadil</em>) set in Jordan. Emphasis will be placed on where these</td>
<td>Watch the review of metric units versus imperial units and how it applies to the original story (<em>A Gift From Fadil</em>) set in</td>
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EDCI 5774 STEM Ed Pedagogy
Units are used (ex: metric in Jordan, imperial in United States).

- Students will practice weighing different volumes of soil/rice and will be required to express the measured amount in both metric and imperial units.
- A presentation will be given on how to calculate postage for packages of varying weights and volumes.
- Following this presentation, students will practice graphing the results of the soil/rice using the worksheets:
  - Graphing: Weight vs. Volume
  - Graphing: Weight vs. Shipping Costs

<table>
<thead>
<tr>
<th>Check for Understanding: (One Class Period)</th>
<th>Understanding: (One Class Period)</th>
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<tbody>
<tr>
<td>Students will discuss their results from the graphing activity. High order thinking questions will be used to promote detailed analysis. Questions such as:</td>
<td>Participate in the class discussion analyzing the results of your graphs. Comparisons of the graph and results will be reviewed. Weight, volume, costs, and trade-offs will be considered for application in the design process.</td>
</tr>
<tr>
<td>o What does the graph represent?</td>
<td>o What does the graph represent?</td>
</tr>
<tr>
<td>o Is the graph for postal rate linear?</td>
<td>o Is the graph for postal rate linear?</td>
</tr>
<tr>
<td>o What does it mean if the graph is or is not linear?</td>
<td>o What is the relationship between volume and weight?</td>
</tr>
<tr>
<td>o What is the relationship between volume and weight?</td>
<td>o How does weight affect cost?</td>
</tr>
<tr>
<td>o How does weight affect cost?</td>
<td>o How does volume affect weight?</td>
</tr>
<tr>
<td>o What are the trade-offs between weight, volume, and cost?</td>
<td>o What are the trade-offs between weight, volume, and cost?</td>
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<tr>
<th>Extensions: (Time Varies)</th>
<th>Extension: (Time Varies)</th>
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<tbody>
<tr>
<td>4th grade:</td>
<td>4th grade:</td>
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<tr>
<td>- Connect to Sub-lesson two with the properties of materials by discussing the trade-offs between weight and strength of the material. Students can also measure and graph the weight of different materials of the same area or volume.</td>
<td>- Participate in the class discussion about the properties of materials by discussing the trade-offs between weight and strength of the material. Measure and graph the weight of different materials of the same area or volume.</td>
</tr>
<tr>
<td>- Connect to Sub-lesson one about plant needs by discussing how soil helps meet the needs of plants by providing nutrients and support to the roots. Guide the students in exploring growing media besides soil that could be used to make the package lighter weight and still meet the needs of the plant</td>
<td>- Participate in the class discussion about how soil helps meet the needs of plants by providing nutrients and support to the roots. Research growing media besides soil that could be used to make the package lighter weight and still meet the needs of the plant</td>
</tr>
</tbody>
</table>
- Have each team of students use different zones for the "ship to" location when calculating postage costs and report their results to the class. Discuss how distance affects shipping cost.

**3rd grade:**
- Have volumes of soil already measured out so students only have to measure weight. Focus assessment on the graphing more than the actual measurement.

**5th grade:**
- Have students calculate the area and perimeter of the packages. Students can make a line graph of area versus volume.

**Closure:**
- Students should complete the handout Our Package Plan that they have been working on during all Lesson 3 sub-lessons. Ask a few students to share their answer to the Thinking Question. Guide the discussion so that all the plant needs and consumer needs are identified. Students should clearly articulate trade-offs between plant needs and consumer needs.
- From the partially completed handout Our Engineering Design Process, review the design problem and constraints from the "Ask" box. Have students fill in the "Imagine" and "Plan" boxes. Remind students that the next step is to create a package based on the plan that they finished in this lesson.

- When completing the Graphing handout on Weight vs. Shipping cost, use the zones that the teacher assigns your team. Participate in the class discussion about how distance affects shipping cost.

**3rd grade:**
- Measure the weight of soil that your teacher give you. Create a good graph with a title, labels, and legend. Be sure you have the dependent variable and independent variable on the correct axis.

**5th grade:**
- Calculate the area and perimeter of the packages that your teacher give you. Make a line graph of area versus volume. Discuss with the class how changing the area affects volume, mass, and shipping cost.

**Closure:**
- Finish the handout Our Package Plan.
- Participate in the class discussion about consumer needs and trade-offs between plant needs and consumer needs.
- Fill in the "Imagine" and "Plan" boxes in the Our Engineering Design Process handout thinking of all the activities in lesson three.
<table>
<thead>
<tr>
<th>Helpful Hints?</th>
<th>Helpful Hints?</th>
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<tbody>
<tr>
<td>• Have students research current postal rates as: <a href="http://www.usps.com">www.usps.com</a></td>
<td>• Have students maintain a vocabulary notebook of new terms.</td>
</tr>
<tr>
<td>• Challenge students to make connections that they might not typically make.</td>
<td>• Online conversion tool: <a href="http://www.convert-me.com/en/convert/weight2volume">http://www.convert-me.com/en/convert/weight2volume</a></td>
</tr>
<tr>
<td>• Make sure students are actively participating in all class activities and discussions.</td>
<td>• Soil is Alive, interactive booklet for students provided by the USDA. <a href="">ftp://ftp-fc.sc.egov.usda.gov/MT/www/about/SoilAlive508.pdf</a></td>
</tr>
<tr>
<td>• Encourage feedback from all students.</td>
<td>• Have fun!</td>
</tr>
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</table>
Appendix I: Plant Health

Slide 1

Plant Health
What to look for in healthy plants

Slide 2

How will I know if a plant is healthy?
• Before we answer that question, it is important to know what the parts of a plant are and their functions.

Slide 3

What are the parts of a plant?
• Leaves
• Stems
• Roots
• Flowers
Now that we know what the parts of a plant are...

• We need to explore the functions of the parts of the plant.

What should a health plant's leaves look like?

What are the leaves function?

• In order to answer that question, we must explore the process of photosynthesis.

( add video clip here)
Slide 7

What should a healthy plant's stem look like?

Slide 8

Vascular plant have stems and play an important part in the health of a plant.

( add video clip here )

Slide 9

What should a healthy plant's roots look like?
Why do plants need flowers?

• To answer this question, we need to explore the process of pollination.
In order for fruit or seeds to develop, they need to be fertilized. This is called pollination.

Pollination is important to the production of many fruits and seeds.

It all begins with the flowers...
Slide 16

...and the pollinators.

Slide 17

Flowers have many different parts, which are all important in the pollination process.

Slide 18

[Diagram of flower parts with labels like Petal, Ovary, Stamen, and more]
Pollen needs to be carried from the male anther on the stamen...

...to the female pistil and down into the ovary...

...for fruit and seeds to develop from a flower.
Pollinators are an important part of the pollination process.

Pollinators pick up pollen from the male part of the flower...

...and transfer it to the female part of the flower...
Now that we know the parts of a plant and their functions...

- It will be easier to ask questions that will make criteria for a package design for a plant very clear.
Appendix II: Measurement of Mass, Weight & Volume PowerPoint

Slide 1
Measurement of mass/ weight/ volume

Slide 2
This balance has a pan for holding the sample while three weights are slid along a set of scaled rails until the mass of the sample is balanced by the weight on the rails.

Slide 3
What is the weight indicated by the scale?
Slide 4
What is being measured in this picture below…

…mass, weight, or volume?

Slide 5
This measuring cup uses both cups and ml units to measure. What would you measure using this tool…

…mass, weight or volume?

Slide 6
What is being measured?

A measuring cup can measure both liquids and solids.
Slide 7
Which of these tools will help to measure volume?

Slide 8
This measuring cup is measuring the volume of rice.

Slide 9
This scale is measuring the weight of the rice.
Could potting soil be measured by volume and/or weight?

Measuring a potted plant in a plastic container

• How would you measure the weight of this item?
• How would you measure the volume of this item?

Let us review the definitions of some types of measurement
**Slide 13**

**Just The Facts… on Measurement**

**Slide 14**

**metric measurement system**

- Definition and illustration (if applicable):
  - A system of measurement based on multiples of 10; basic units are meter (length), gram (mass), and liter (volume or capacity).

**What are some metric measurements you could collect from this data?**

**Associated terms:**

- 
- 
- 
- 
- 
- 
- 

**Slide 15**

**U. S. Customary measurement system**

- Definition and illustration (if applicable):
  - The system of measurement commonly used in the U.S.; units are inches, feet, yards, and miles (length); ounces, pounds, and tons (weight); ounces, cups, pints, quarts, and gallons (capacity).

**What are some U. S. Customary measurements you could collect from this item?**

**Associated terms:**

- 
- 
- 
- 
- 
- 
- 

---

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Slide 16

**Mass**

Definition and illustration (if applicable):

The amount of matter in an object which is determined through inspection of the object. Weight is determined by the pull of gravity on the mass of an object. Weight of an object changes depending on the gravitational pull at its location.

Could you measure the mass of this item? 

What are some variables that might change the mass of this item?

Associated terms: [insert terms]

---

Slide 17

**Volume**

Definition and illustration (if applicable):

The amount a container can hold; the amount of space occupied by an object.

Would the volume of this item change if it were placed in a cardboard box for shipping?

How would you calculate that volume?

Associated terms: [insert terms]

---

Slide 18

**Weight**

Definition and illustration (if applicable):

Weight is determined by the pull of gravity on the mass of an object. The same object, measured at different locations, might weigh different amounts depending on the gravitational pull at its location.

Associated terms: [insert terms]
Slide 19
Using what you know about measurement...

- How would you measure the weight and/or mass of this item?
- How would you measure the volume of this item?

___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________

Slide 20
Is measuring the mass/ weight / volume of this item all you need to know in order to ship this item?

___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
Appendix III: Postage PowerPoint

Slide 1
How to Calculate Weight by Volume

This information will be useful to help calculate how heavy a box is, so that proper postage can be added to that particular box.

Slide 2
Let's Get Started

Things You’ll Need:

Measuring Tape…

…and something to measure!

Slide 3
Measure the item’s length in centimeters

Measure the item’s height in centimeters

Measure the item’s width in centimeters

Now that you have your data, it is time to plug in a formula.

Length \times height \times width

L \times H \times W
The first part of the formula is: 

\[ L \times H \times W \]

---

The second part of this formula is to divide your answer by 6000

\[ \frac{L \times H \times W}{6000} \]

This formula will give you the volumetric weight in kilograms.

---

In order to use this information to calculate proper postage for the package, there is one more step.
You will need to convert your answer (which is in kilograms) into pounds. The conversion formula for this process is:

\[
\text{Kilograms} \times 2.2 \quad \text{pounds}
\]

Current Postal Rates

- Once you know the weight of your package, you can plug that information into a chart which will help you determine your postal rate.
- This rate will depend on which zone you are in and which zone you would like to ship your package.
- Use the following website to help with those calculations: [http://www.usps.com/tools/calculatepostage/welcome.htm](http://www.usps.com/tools/calculatepostage/welcome.htm)
Appendix IV: Handouts

Name: ________________________________________ Date: _____________________

Plant Structure and Function

Directions: Write the part of the plant in the correct box.

Structure

Root

Stem

Leaves

Flower/pod

Function

Support, water transport

Reproduction

Water absorption and transport

Food production

Directions: Draw an arrow from the plant structure to the correct function.
Our Package Plan

Sketch your team’s package plan

**Plant Needs**
Our package will protect the plant

- leaves by __________________________________________
- stem by __________________________________________
- roots by __________________________________________

Our package will meet the plant need for

- air by __________________________________________
- light by _________________________________________
- water by _________________________________________

Our package will be easy to carry by ________________________________________

**Consumer Needs**
Our package will communicate plant needs by ________________________________

Our package will be made out of ______________________.

We want our package to cost _____________ to mail. So it should weigh _________ grams and hold _____________ liters of soil.

*Thinking Question:* What is more important, meeting plant needs or meeting consumer needs? (Hint: think of trade-offs)
Our Engineering Design Process

Directions: In the boxes below, write or draw a picture explaining how your team completed each step of the Engineering Design process.

<table>
<thead>
<tr>
<th>Step of the Engineering Design Process</th>
<th>How did your team complete this step?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ask</td>
<td></td>
</tr>
<tr>
<td>Imagine</td>
<td></td>
</tr>
<tr>
<td>Plan</td>
<td></td>
</tr>
<tr>
<td>Create</td>
<td></td>
</tr>
<tr>
<td>Improve</td>
<td></td>
</tr>
</tbody>
</table>
Graphing:
Weight vs. Volume

Graph your results below using IMPERIAL Units.

Graph your results below using METRIC Units.

1. What did your results show you about weight and volume?
2. Was there a difference in the findings between metric and imperial units?
Questions:
1. Is it more expensive to mail a package that is heavy or light weight? Why?

2. Is it more expensive to mail a package with a large weight or a large volume? Why?

Extra Credit: Does the location of where the package is sent affect the cost of shipping?