INVESTIGATING THE COMPOST

Performance Standard 12E/11A/11B/13A.H

Students will apply the processes of scientific inquiry or technological design to examine earth's resources quantitatively accordingly:

- *Knowledge*: Define biodegradability and the factors which affect is process,
- *Application*: Conduct an investigation of compost biodegradability using natural materials, and
- *Communication*: Report the findings of the investigation and generate possible societal applications for these findings.

Procedures

1. ***In order to know and apply concepts that describe the features and processes of Earth and its resources (12E) and apply the concepts, principles and processes of scientific inquiry (11A) or technological design (11B), and apply the appropriate principles of safety (13A),*** students should experience sufficient learning opportunities to develop the following:
   - Generate inquiry questions for scientific inquiry or potential strategies for technological design investigations to test biodegradation of common natural materials (paper products, garbage, yard wastes etc.)
   - Research available resources for pertinent foundational and quantitative information from prior studies.
   - Design and conduct scientific inquiry or technological design investigation to test the biodegradability of composting substances.
   - Determine appropriate materials, equipment and data-collection strategies, procedural sequence, success criteria, and safety precautions to test the posed hypothesis or design proposal.
   - Diagram schematic of technological design test,
   - Use consistent metric measuring and recording techniques with necessary precision,
   - Graph data appropriately according to time and composition variables (and others, if applicable),
   - Analyze results and interpret trends.
   - Report the results of tests of biodegradability of various natural materials.
   - Review experimental procedures or explanations for possible faulty reasoning or unproven statements.
   - Compare findings from other presentations to consider consolidation of procedures, explanations or results for future investigations.

   Note to teacher: This activity relates to knowledge associated with standard 12E, while addressing the performance descriptors for stage H within standard 11A or 11B and 13A. An extension of this activity is directly associated with the performance descriptors for 13B. The Illinois Department of Commerce and Community Affairs, may be contacted for classroom assistance for composting resources: http://www.commerce.state.il.us/ho_recycling_energy.html

2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Begin the investigation of the composting process with foundational questions about prior knowledge of biodegradation and the materials which can or must be involved. Determine the capabilities of the school or potential home settings for the successful completion of this assignment. Set the stage for the variety of investigations which can be incorporated into this unit. Students will be asked to conduct an investigation of biodegradability over a 1-3 month period. Within the same curricular framework, students may investigate the biological or chemical changes in composting reactions as a scientific inquiry investigation; they will keep the structure of the compost facility constant. Others may investigate the "engineering" features of a compost "facility" while keeping the biological and chemical factors constant.

- Determine the parameters for this investigation through class discussion. The class should decide all controlled variables (maximum volume, procedural requirements, such as amount of added moisture, tolerance of temperature variations, etc.), data-collection requirements and degradable materials (only leaves, only certain kinds of leaves, grass clippings or not, specific food scraps, etc.)
- Individual or groups of students should propose their own design for testing biodegradability factors. They may test the effect of moisture or temperature, specific food scraps, volume designs, composition ratios (of leaves to grass clippings, etc.), depending on class decisions. Warn students about the generation of odors.
- Create individual or group investigation design with all procedural steps, safety precautions, necessary materials and equipment, data-collection tables and applicable sketches.
- Maintain a log of all activities, observations, and results.
- Inspect the compost pile regularly to collect data. They may decide to turn over the compost pile once a week to redistribute the materials; this process may become part of the investigation or remain as a constant. Students should be careful not to handle the compost with their hands, but if they should have any physical contact with the compost, they should wash thoroughly.
- At the end of the experiment, analyze the results of the biodegradability of each of the materials and the variables they tested.
- Ask each student to present their findings, describing and explaining the results of the experiment. Student should prepare graphic tables or charts that compare the variables of biodegradability from their investigation.
- Students should conclude the investigation by comparing findings, procedures and data to generate further investigation possibilities, such as using earthworms in vermi-composting or to use commercial in-vessel composting.

4. Evaluate each student's work using the Science Rubric as follows and add the scores to determine the performance level:
   - *Knowledge*: The explanation of biodegradability and the factors that affect the process were complete and correct.
   - *Application*: The observations and procedures for the investigation were thorough, well-organized, and well-detailed.
   - *Communication*: The findings from the student investigation were well-focused, well-detailed, and thoroughly compared and explained the variables that were tested.

Examples of Student Work not available

Time Requirements

- Two to four weeks
  Five-eight minutes for each presentation

Resources

- Notebook or journal for each student
- Composting supplies, facilities and equipment (thermometers, beakers for delivery of constant moisture, trowels, shovels, etc.)
- Science Rubric

Special notes for consideration:

1. It will be more preferable to start this project in October or March. Winter conditions of lowered temperatures and precipitation (snow, ice) will inhibit the necessary entry of oxygen into the compost system.
2. It is suggested that the optimum temperature within the compost system ranges from 150 – 175 degrees F, if vegetative materials (yard wastes, food scraps, etc.) are used.
3. Turning the compost involves variables that should be considered:
   - if turned too often: decomposition slows,
   - turn only when the system's temperature has stabilized---to redistribute nutrients and decomposition processes, and
   - generally, turn weekly in the first two weeks to distribute materials initially (to prevent odors) and keep the system stable for approximately 3 weeks without turning.
4. It may not be necessary to add any moisture at all, depending on the decomposing materials. If food wastes are included, less moisture is necessary. If the system is too wet, the process is slowed.
5. Vermi-composting (using earthworms) or commercial in-vessel composting may be considered for inclusion as design parameters, as well.
6. For possible school composting grant funding: http://www.commerce.state.il.us/com/recycling/school_recycling_grants.html

The Essentials of Composting

Biological Process

The compost pile is really a teeming microbial farm. Bacteria, the most numerous and effective composters, are the first to break down plant tissue. Fungi and protozoans soon join the bacteria and, somewhat later in the cycle, centipedes, millipedes, beetles and earthworms do their parts.

Materials

Anything growing in your yard is potential food for these tiny decomposers. Microorganisms use the carbon in leaves or woodier wastes as an energy source. Nitrogen provides the microbes with the raw element of proteins to build their bodies.

Everything organic has a ratio of carbon to nitrogen (C:N) in its tissues. The following table can help you judge the ratio of your compost ingredients.

Carbon: Nitrogen Ratio

Grass Clippings	20:1
Leaves	60:1
Wood	700:1
Sawdust	500:1
Fruit and Vegetable wastes	35:1
Straw	80:1
Rotted Manures	20:1

A C:N ratio of 30:1 is ideal for the activity of compost microbes. This balance can be achieved by mixing two parts grass clippings with one part leaves. This combination is the "backbone" of most compost systems.

Surface Area

The more surface area the microorganisms have to work on, the faster the materials decompose. Chopping your garden wastes with a garden tool, or running them through a shredding machine or lawnmower, will speed their decomposition.

Volume

A large compost pile will insulate itself and hold the heat of microbial activity. Its center will be warmer than its edges. Piles smaller than 3 feet cubed (27 cu. ft.) will have trouble holding this heat, while piles larger than 5 feet cubed (125 cu. ft.) don't allow enough air to reach the microbes at the center. These proportions are of importance only if your goal is a fast, hot compost. Slower composting requires no exact proportions.

Moisture and Aeration

All life on Earth, including compost microbes, needs a certain amount of water and air to sustain itself. Microbes function best when the compost heap has many air passages and is about as moist as a wrung out sponge. Extremes of sun or rain can adversely affect this moisture balance.

Four Types of Bins to Build

Snow Fence Bin

Bins made with prefabricated snow fencing are popular because they are simple to make and easy to move and store. To build this bin, buy the appropriate length of prefabricated fencing and fasten to two-by-fours (2x4s) used for the corners.

Woven Wire Bin

One easy-to-make, economical container requires only a length of woven wire fencing or snowfence. Multiply the diameter you want for the compost pile by 3.2 to determine the length of fencing to buy. Fasten the ends with wire or with three or four small chain snaps (available at any hardware store) to make a circle. Compost bins can be made with bricks or cement blocks. Just lay the blocks without mortar, leaving spaces between each block to permit aeration. Stack them to form three sides of a square container. This type of bin is sturdy, durable and easily accessible.

Wooden Bin

Covered wooden bins allow convenient protection from pests and heavy rains. Construct bins

How to Make Compost

Remove grass and sod cover from the area where you will construct your compost pile to allow materials direct contact with soil microorganisms. The following "recipe" for constructing your compost heap is recommended for best results:

1st layer: 3"-4" of chopped brush or other coarse material on top of the soil surface allows air circulation around the base of the heap.

2nd layer: 6"-8" of leaves, grass clippings, sawdust, etc. Materials should be "sponge" damp. Since most finished yard waste compost has a slightly alkaline pH you may want to sprinkle sulfur over the heap to increase its acidity.

3rd layer: 1" of soil serves as an inoculant by adding microorganisms to the heap. This layer is not necessary since the inocullum needed for composting is usually present; however, it will help to speed the composting process.

4th layer: 2"-3" of manure or a handful of commercial fertilizer to provide the nitrogen needed by microorganisms. Add water if the manure is dry.

5th layer: Repeat steps 1-4 until the bin is almost full. Top off the heap with a 4"-6" layer of straw and scoop out a "basin" at the top to catch rain water.

A properly made heap will reach temperatures of 140 -160 degrees in four to five days. At this time, you'll notice the pile "setting," a good sign that your heap is working properly. Initially the pH of the compost pile will be very acidic, 4.0-4.5; however, as the process nears completion, the pH rises to approximately 7.0-7.2.

After five to six weeks, fork the materials into a new pile, turning the outside of the old heap into the center of the new pile. Add water if necessary. You shouldn't need to turn your heap a second time. The compost should be ready to use within three to four months. A heap started in late spring can be ready for use in the autumn. Start another heap in autumn for use in the spring.

You can make compost even faster by turning the pile more often. Check the internal temperature regularly; when it decreases substantially (usually after about a week), turn the pile.

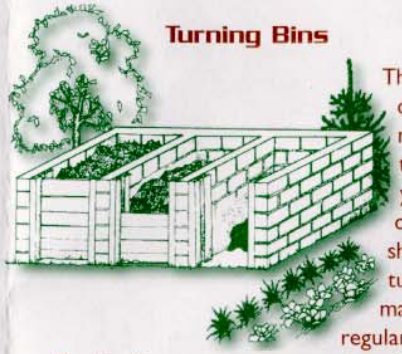
Compost is ready to use when it is dark, brown, crumbly, and earthy smelling. Let it stabilize for a few extra days and screen it through a 1/2" screen if you want the finest product. Turn your soil, apply 1"-3" layers of compost, and work it in well.

The following troubleshooting chart is a guide to more efficient composting.

Symptoms	Problem	Solutions
The compost has a bad odor.	Not enough air.	Turn it, add dry material if the pile is too wet.
The center of the pile is dry.	Not enough water.	Moisten and turn the pile.
The compost is damp and warm only in the middle.	Too small.	Collect more material and mix the old ingredients into a new pile.
The heap is damp and sweet-smelling but still will not heat up.	Lack of nitrogen.	Mix in a nitrogen source like fresh grass clippings, manure or fertilizer.

with removable fronts or sides so that materials can be easily turned. Old wooden pallets can be used for construction. Wire mesh can be used on the sides to increase air flow.

Prefabricated compost bins can be purchased through most gardening catalogues.



Turning Bins

This is a series of three or more bins that allows you to make compost in a short time by turning the materials on a regular schedule. Turning bins are most appropriate for gardeners with a large volume of yard waste and the desire to make a high quality compost. You can also turn your compost with only one bin. Simply remove the bin from around the pile when it's time to turn it, set up the empty bin nearby, and fork the material back into it.