



*Drexel-SDP GK-12 ACTIVITY*

## Competition Composter

**Subject Area(s):** Chemistry, Geometry, Data Analysis & Probability, Physical Science, Science & Technology

**Activity Title:** Competition Composter

**Grade Level :** 6 (5-12)

**Time Required:** 1 ½ hours – Preliminary Discussion and Building Composter  
10 minutes per day for 5 school days to make and document observations  
45 minutes – Final Observations and Discussion/Proper Disposal of Materials

**Group Size:** 4 or 5

**Expendable Cost per Group:** US\$1

### Summary:

Students respond well to design competitions. In this activity, they will explore new ideas about solid waste management and nutrient cycling in the environment, while engaging in a design competition. They will design bioreactors with soda bottles, which will mimic real-life landfills or composters based on the environmental conditions within the reactors. In order to measure the extent of decomposition of garbage achieved in their bioreactors, they will use a soil nutrient test kit to measure changes in the soil at the base of their reactors. In this way, they will discover how nutrients are cycled throughout the environment, while observing biodegradation.

### Engineering Connection:

Solid waste management problems, though they are not new, currently pose several real life challenges and concern public health, economics, conservation, aesthetics, engineering design and other environmental and ecological issues. An integrated approach to dealing with solid waste includes reduction, recycling, waste transformation and landfilling. In this activity students will begin to understand why all of these processes are important. Engineers must employ, manipulate and encourage natural decomposition processes in order to manage solid waste safely and efficiently.

## Engineering Category

(1) relates science concept to engineering,

## Keywords

solid waste, biodegradable, compost, composting, nutrient cycling, landfill, bio-reactor, garbage trash

## Pre-requisite knowledge

Students should basic knowledge of the flow of energy through an ecosystem (e.g., food chains, food webs.)

## Educational Standards

- 3.2.7.A Explain how certain questions can be answered through scientific inquiry and/or technological design
- 3.2.7.B Design a controlled experiment by specifying how the independent variables will be manipulated, how the dependent variable will be measured, and which variables will be held constant
- 4.6.7.A Explain the flow of energy through an ecosystem (e.g., food chains, food webs)
- 4.6.7.C Describe the response of organisms to environmental changes (e.g., changes in climate, hibernation, migration, coloration) and how those changes affect survival
- 4.3.7.A Identify environmental issues and explain their potential long-term health effects (e.g., pollution, pest control, vaccinations)

## Learning Objectives

After this activity, students should be able to:

- Describe the difference between items that are biodegradable and non-biodegradable
- Describe how engineer's use natural processes to reduce solid waste in landfills
- Describe how your community can reduce solid waste through composting
- Discuss some advantages and disadvantages of aerobic and anaerobic bioreactors
- Describe how nutrients are cycled in the environment

## Materials List

For the class to share:

- Soil nutrient test kit (NPK)
- garbage (apple cores, banana peels, egg shells, coffee grinds, lettuce leaves, etc.) – separated so that each group gets an equal amount of each
- a few empty plastic food containers cut up into pieces (about 1 cm by 1 cm)
- a roll of clear packing tape

Each group needs:

- 2 or 3 empty 2-liter soda bottles
- scissors
- razor blade
- marker
- 3 cups of garden soil (do not use potting soil because it does not contain the natural bacteria needed to decompose organic matter)
- rubber gloves

- 5-10 night crawler worms (optional, at least half the groups should use the earthworms and design an aerobic reactor for comparison with the others)
- 1 cup of water

## **Introduction / Motivation**

Read the following facts to the class:

“The typical American throws away about five pounds of trash a day, according to the Environmental Protection Agency\*. That adds up to about 200 million tons of American garbage a year!

Americans are making waste products faster than nature can break them down and we are using up resources faster than they can be replaced.

This adds up to trouble for the environment. Where does all that garbage go? What's in my garbage? What can be done to help dispose of garbage? How can I make less garbage?

Garbage isn't just the smelly rotting fruits, vegetables or meat that we throw away in our homes. That's only a small part of all the stuff we throw away. We create more waste that we never see; for example, construction, mining, or factory waste. 40% of our trash is paper, 17.5% is yard waste, 8.5% is metals, 8% is plastic, 7.5% is food waste, 7% is glass and 11.5% is everything That's a lot, but it's only the tip of the iceberg....

Did you ever wonder what happens after you set your garbage can out on the curb? Most of our garbage is incinerated or buried in landfills. Less than a quarter of our waste is recycled.

A landfill is not just a huge mound of trash. A sanitary landfill is carefully planned, built, managed and monitored to protect a community from the dangers of decomposing garbage.

### **What can you do to help?**

Make less trash in the first place! This would reduce the amount of natural resources needed to make the materials and eliminate environmental, economic, and public health problems. Seventy percent (70%) of landfilled waste could be reused or recycled.”

These garbage facts are from <http://idahoptv.org/dialogue4kids/season6/garbage/links.cfm>

What did you think about what was read. Giving some thought to where your trash goes and how much trash you dispose of is the first step to becoming environmentally friendly or “Green.” While much attention has been given to the idea of being “green” in recent years, this is not a new concept. One of the ways that you can reduce food waste going into a landfill is by composting. Unfortunately, current landfilling practices do not allow even food waste to decompose because of dangerous gases which could form. Instead the landfill is covered in such a manner that deprives even biodegradable wastes of light, air, and water thereby preventing decomposition by natural means. Let’s explore what composting is and how it can help a little more. Then you will have an opportunity to build your own bioreactor, which may behave like an efficient composter or a typical landfill depending on your design.

Watch the video:Its Gotten Rotten, available at: <http://compost.css.cornell.edu/IGR.html>

### Vocabulary / Definitions

Word	Definition
Biodegradable	capable of decaying through the action of living organisms
Composting	a managed process in which food, yard and animal wastes decompose to form new soil or fertilizing material
Decompose	to separate or resolve into constituent parts or elements
Decomposer	an organism, usually bacteri, fungi or earthworms, that breaks down the cells of dead plants and animals into simpler substances
Aerobic	requiring the presence of air or free oxygen
Anaerobic	in the absence of air or free oxygen
Nutrient cycling	the process through which nutrients like nitrogen, phosphorous and potassium, cycle through the environment by way of soil, plants and decomposers
Landfill	is a site for the disposal of waste materials by burial; also known as a dump or rubbish dump

### Procedure

#### Before the Activity

Find a place to store the bioreactors like on a windowsill.

#### With the Students

1. Discuss the design challenge with the students.
2. Explain the environmental conditions required for biodegradation of organic material: LAWS (light, air, water and soil).
3. Tell the students what materials you are giving them to decompose.
4. Explain the difference between aerobic and anaerobic conditions.
5. Talk about nutrient cycling and the indicators you will measure with the test kits during your challenge. Explain the proper use of the test kits (per package directions.)
6. Briefly discuss composting with worms. Some basics are listed below, but you can explore as much as time permits: Try the link at: <http://yucky.discovery.com/noflash/worm/pg000223.html>
  - Earthworms are not insects.
  - They are classified as annelids, meaning that they are segmented worms.
  - Earthworms are not choosy. They like moisture, food and darkness.
  - Earthworms will eat any organic material. They especially enjoy kitchen scraps.
  - You can also feed them limited quantities of paper trash, too.
  - Only two minutes of direct sunlight can kill a worm
7. Read the Bottle Composting Worksheets or directions from the website directly.

8. Divide the class into teams. Allow each team 10 or 15 minutes to discuss their design. (Ask them to submit a preliminary labeled schematic.)
9. Construct the Bioreactors from the bottle composting directions.
10. Distribute soil and garbage
11. Test the soil with the kits and record the initial values in a notebook.
12. Fill the columns with soil and kitchen scraps. Let the students layer the materials according to their design. Let them experiment with compacting and decide how much cover to put on top. (Too little cover will cause odors and may attract fruit flies. Too much cover will prevent air and light from reaching the garbage.)
13. Pour water over the garbage and soil.
14. Place the columns in the designated place and observe daily.
15. After one or two weeks, have the students dump the contents into recyclable plastic bags and measure the soil nutrients at the bottom. Also have them observe which items decomposed the most.

### **Investigating Questions**

- What would happen if plants and animals (organisms) that die did not decay?
- What would happen if all of our waste was non-biodegradable?
- What ways could you use compost in your community?

### **Assessment**

#### **Pre-Activity Assessment**

Have students hypothesize about the performance of their reactor and explain why they think they will observe significant decay of certain materials and not others. Allow them time to do more background research if necessary.

#### **Activity Embedded Assessment**

Review the students' observations. Talk about what they mean.

#### **Post-Activity Assessment**

A full lab report should be completed which includes all observations linked to the students final results and conclusions. Have them include a comparison between each team's design and the team's design that had the most decomposition.

### **Activity Extensions**

Have the students investigate where their trash goes in their local town after they throw it out. Track different materials including recyclables, lawn and garden trimmings, etc.

Start composting at your school on a regular basis. Find information at:  
<http://compost.css.cornell.edu/CIC.html>

## **References**

Center for Online and Distance Learning, Los Angeles County Office of Education, "Bottle Composting", Available at:  
<http://teams.lacoe.edu/DOCUMENTATION/classrooms/gary/plants/activities/articles/composting.html>

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[http://www.associatedcontent.com/article/230269/how\\_to\\_make\\_a\\_plastic\\_soda\\_pop\\_bottle\\_pg2.html?cat=32](http://www.associatedcontent.com/article/230269/how_to_make_a_plastic_soda_pop_bottle_pg2.html?cat=32)

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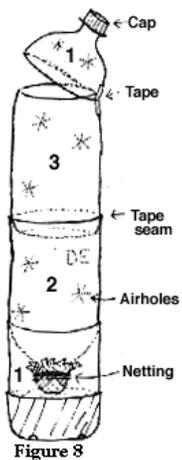
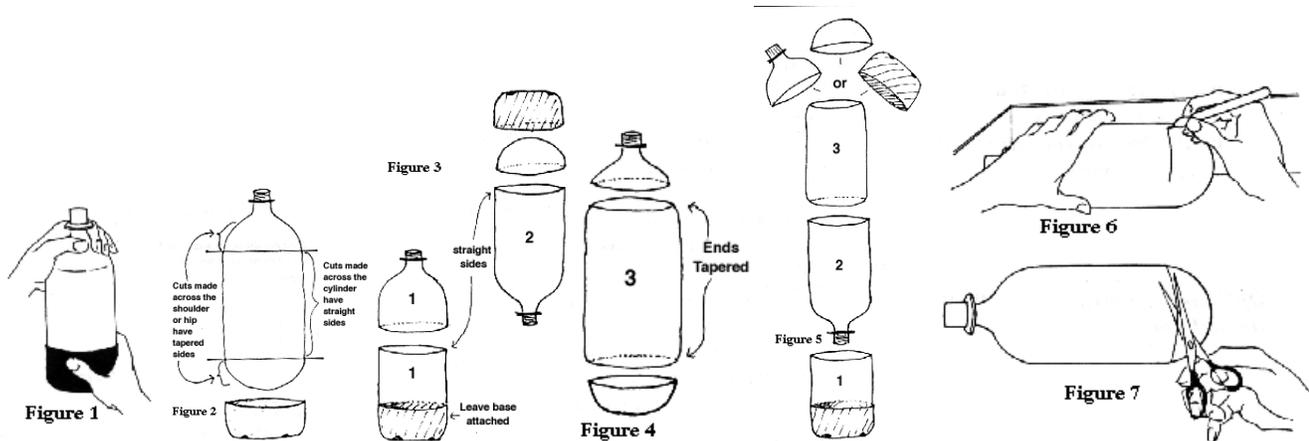
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# Bottle Composting

Center for Online and Distance Learning, Los Angeles County Office of Education, "Bottle Composting", Available at:

<http://teams.lacoe.edu/DOCUMENTATION/classrooms/gary/plants/activities/articles/composting.html>



## Construct a compost column from 2-liter soda bottles.

- Fill a two-liter bottle with hot water and replace the cap. The heat will melt the glue and allow you to peel off the label and twist off the bottom easily.
- Study Figures 2 through 5 to determine where to cut the bottles for a two or three bottle compost column. Options for cutting the bottles
- Pour out the water and place the bottle on its side against a solid object, such as the sides of a drawer. Mark a ring on the bottle (Figure 6) where you want to make the cut.
- Use a razor blade or knife to start a cut after marking the bottles, and then finish the cut with scissors (Figure 7). Note in Figure 5 above that the shoulder of bottle #3 is cut at so that it fits into bottle #2.
- Provide air and testing holes by poking holes in the sides of the bottle with a hot needle (heated in a candle flame, or a bunsen burner) or the soldering iron.
- Put a piece of netting or nylon stocking over the spout of bottle #2, securing it with a rubber band.
- Put the pieces of column together, Figure 8.