

CASIO T. E. A. M. S. WORKSHOP

Hot Hosts in the Compost

Grade Level: 9th - 12th

Subject: Environmental Studies

SOL's: AII.19
BIO 1 5 8 9
CHEM 1 4
PHYS 2 7 8

Objective(s): The student will be able to:

- ◆ Build and maintain a compost pile.
- ◆ Take regular temperature readings in order to :
 - compare how quickly the system heats up
 - determine how hot the system gets
 - study how long the system retains its heat
- ◆ Analyze temperature readings
- ◆ Determine optimum temperature and depth for maximum acceleration of natural decaying processes
- ◆ Use a graphing calculator to investigate scatter plots and determine the equation of the curve of best fit.
- ◆ Write the equation for the curve of best fit in different forms
- ◆ Convert Fahrenheit and Celsius degree measurements
- ◆ Find median and mode of data

Background: Composting is a technique used to accelerate the process of natural decay. The technique converts organic wastes to a mulch which is used to fertilize and condition the soil. Leaf waste decomposes naturally in about two years, while composting - when correctly done, can take as little as 14 days.

Composting provides a partial solution to an issue of great concern in many communities. All around the country, landfills are filling up, garbage incineration is becoming increasingly unpopular, and other waste disposal options are becoming ever harder to find.

Composting can be a way not only of reducing the amount of waste that needs to be disposed of, but also of converting it into a product that is useful for gardening, landscaping, or house plants. It also addresses the solid waste issue, and provides an educational way of instilling in students a sense of environmental stewardship.

Contrary to the “out of sight, out of mind” philosophy, students who compost become aware of organic wastes as potential resources. They learn through direct experience that they personally can make a difference and have a positive effect on the environment. Composting also provides a rich topic for scientific investigation and discovery. It involves interactions between biological, chemical, physical, and mathematical processes.

Materials Needed:

Electronic data-collection device, temperature probe in channel 1, calculator with the appropriate program, link cable, 2 yard stick, pencil and paper.

Introducing the Experiment:

Describe the experimental procedure. Brainstorm with the class, and ask probing questions, such as: “What do you think a graph of the temperature of the probe tip inserted, at different depths into the compost pile, would look like?” Have a short review/discussion comparing Celsius and Fahrenheit temperature scales. Have students draw the expected graph, and hypothesize on possible reason(s) for such graph.

Experimental Procedure:

- Have students work in groups of three: Student #1 - takes temperature readings
Student #2 - takes height measurements (ground = 0)
Student #3 - records data
- Mount temp probe on extension rod . Secure with electrical tape.
- Attach the temperature probe to channel 1 of the EA-100.
- Stand the meter stick next to the compost pile (with the 0 end **on** the ground).
- Using the meter stick as an indicator (distance from ground 0), insert the probe into the compost pile and record the temperature. The student will continue to take temperature readings, at regular intervals, from ground level to the top of the pile (i.e. 0 = ground level, 5cm, 10cm, etc). Refer to diagram A.
- To record temperatures:
 1. Push the red “**ON**” button on the EA-100.
 - a. If you see the word “**multimeter**” in the bottom left of the screen, push the **MODE** button until you see only the word **DONE**. (It should not be flashing.)
 - b. If *channel 1* does not appear in the upper left hand corner, you must push the **CH-View** button until you see it.
 2. Push **SHIFT MODE**. The screen should flash READY
SAMPLING
DONE
 - a. Use the **dataLOG** button to scroll through the choices for total sampling time until you get to .000 Then hit **TRIGGER**.
 - b. Use the **dataLOG** button to scroll through the choices for number of samples until you get to 10. Then hit **TRIGGER**.
 - c. Use the **dataLOG** button to scroll through the choices for time until you get to 0. Then hit **TRIGGER**.
0 = time recording off
1 = absolute time
2 = relative time
 3. **READY** should appear on the left of the screen. The temperature will not be fluctuating.
 4. Push the probe plugged into *channel 1* about 40 cm into the compost pile each time, starting at ground level.
 5. Wait 20 seconds then push **TRIGGER** on the EA-100 to record the temperature reading that will appear in the window.
 6. Continue recording temperatures until you have sampled from the ground to the top of the compost pile. After taking 10 readings, the EA-100 should say **DONE** on the left of the screen.
 7. Turn EA-100 off and remove probe.
 8. **Return to the classroom.**
 9. Turn on both the EA-100 and the 9850 color graphics calculator and link them.
 10. Arrow to program and press EXE (or press ALPHA B).
 11. Arrow to RECEIVE2* program and press EXE.
(*To install RECEIVE2, see last page.)
 12. Press MENU. Arrow to STAT and press EXE (or press 2).
 13. Use Del-A (F4) to delete List 1 and enter height measurements into List 1.
 14. Record data in Lists 1 and 2 into Height-Temperature chart on the data sheet.
 15. Press F1 (GPH). Then F6 (SET).
 16. Set Graph Type: Scatter (F1)
X List: List 1 (F1)

Assessment: Students should analyze the data and graphs produced. The following questions will help in the analysis of the data.

1. Make a note about the temperature ranges (curve) that you might have expected from this research.
2. How do the actual values compare to what you might have expected?
3. What are some factors that contribute to the rise in temperature in the compost pile? Explain.
4. There is a temperature range within which decomposition is most rapid. Research the literature, or the net, and describe the reason(s) for this range.
5. Composting presents an interaction between biological, chemical, and physical processes. Describe how each of these factors interacts and influences the rate of decomposition.
 - a) *Chemistry:* It plays a role in composting because for rapid microbial growth one needs to provide the right mix of nutrients. Explain how nutrients such as carbon and nitrogen, and their availability, may affect such variables as microbes, particle size, pH, and moisture content.
 - b) *Physics:* Physical characteristics of the compost ingredients, including moisture content and particle size affect composting. Explain how these, and other considerations such as the size and shape of the system, can affect the rate of aeration and decomposition.
 - c) *Biology:* In outdoor compost systems, there is a complex food web at work. Individual species, or their populations can be charted through something as simple as daily temperature measurements. Observe compost organisms and draw a food web.

Exploring Further:

1. Monitoring Compost pH.
 - a. Soil Test Kit
 - b. pH Paper
 - c. Compost Extractions (using a calibrated meter or pH paper, the student can measure pH in a compost extract made by mixing compost with distilled water).
2. Measuring Moisture Content.
3. Measuring Particle Size.

Particle size affects the availability of certain elements (carbon and nitrogen), and affect the rate of microbial activity and decomposition rate.
4. Measuring Aeration

CASIO TEAMS WORKSHOP

Team #8

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MATH EXTENSION

- I. Using the given formula, express your data for the following temperatures on the Fahrenheit scale.

$$F = 1.80(C) + 32$$

	Temp. C	Temp F
Ground	_____	_____
Center	_____	_____
Top surface	_____	_____

- II. From the list(s) of data collected determine the mode and median of each list.

	List 1	List 2	List 3
Median	_____	_____	_____
Mode	_____	_____	_____
At what heights did these readings occur?			
Ht. Median	_____	_____	_____
Ht. Mode	_____	_____	_____

- III. What could you conclude from this data in terms of the heat lost and the heat generated. What roles do aeration and decomposition play ?

DATA WORKSHEET

	HEIGHT	TEMP		HEIGHT	TEMP
1.			1.		
2			2.		
3			3.		
4			4.		
5			5.		
6			6.		
7			7.		
8			8.		
9			9.		
10			10.		

GRAPHS