INTRODUCTION TO WASTE MANAGEMENT

Municipal Solid Waste Management
Waste Management in Alabama is as diverse as the state's natural resources. Municipal solid wastes are generated in homes, commercial establishments, institutions, and industries. Municipal solid waste varies from yard waste to food scraps and from construction and demolition debris to office and classroom paper. In the United States, each individual produces 2,555 pounds of garbage each year. In Alabama, each individual produces approximately 4.5 pounds of municipal solid waste a day. Local governments, waste management companies, and consumers have established methods of disposing of waste in an environmentally friendly manner.

Recycling is the process by which used items are reconditioned and are adapted to a new use or function. Recycling is a waste management method that can be a responsible, cost-effective way to help solve some of Alabama's waste disposal problems. Recycling helps preserve natural resources, reduce pollution, and save energy.

Composting is a low-cost disposal method whereby organic material is accumulated in mounds or containers to bring about decomposition by microorganisms such as bacteria or fungi. Composted items can be used as a soil conditioner in landscaping and gardening.

Incineration is a disposal method involving the burning of solid waste to reduce volume, with or without the recovery of energy.

Landfilling is the major disposal method of solid waste in Alabama. A landfill is a system of trash and garbage disposal in which waste is buried between layers of earth in such a manner that minimizes environmental hazards. New EPA regulations called subtitle D make landfilling more environmentally friendly than before, but much more expensive.

Hazardous Waste Management
In addition to municipal waste management, Alabama also must manage hazardous wastes produced in the state. *Hazardous waste* is any solid, liquid, or gaseous material that is no longer of use in its present form and would cause injury or death to living organisms and would pollute land, air, or water if improperly disposed. Some examples of hazardous wastes include oil, batteries, pesticides, and oil paints. Hazardous wastes may be managed through minimization, resource recovery such as recycling or reuse, treatment, or disposal.

The *Resource Conservation and Recovery Act* (RCRA) classifies hazardous waste into two categories: characteristic hazardous waste and listed hazardous waste. *Characteristic hazardous wastes* exhibit one or more of the following traits: ignitability, corrosivity, reactivity, or toxicity. *Listed hazardous wastes* are incorporated into lists from the RCRA rules. They exhibit one of the previously listed characteristics or contain any number of toxic constituents that have been shown to be harmful to health and the environment.

Household hazardous waste, unlike hazardous waste generated by industry, is not regulated in Alabama by the Alabama Department of Environmental Management or the U.S. Environmental Protection Agency. The best way to manage household hazardous waste is to avoid generating hazardous products.

Disposal may be reduced or eliminated by giving leftover products away, recycling materials when possible, using less hazardous alternatives when possible, and buying only the amounts of products needed.

Effects Of Biodegradable Waste On Dissolved Oxygen

OBJECTIVES:

Students will be able to:

1. Explain the effects of biodegradable waste on oxygen levels in aquatic ecosystems.
2. Perform an experiment to demonstrate the effect of biodegradable wastes on oxygen levels in an aquatic ecosystem.
3. List a few of the sources of biodegradable pollutants entering aquatic systems.

Grades:

6-8

Subjects:

Science, Math, Social Studies

Time Needed:

Two 45-minute periods

Materials:

milk
two small beakers or baby food jars
2 mL (about half a teaspoon) of dry yeast
one 10 mL graduated cylinder
3 test tubes in a rack
stirring stick
one 5 mL pipette or an eye dropper
methylene blue solution
test tube labeling

BACKGROUND:

Oxygen is a vital component of most ecosystems. Most living things need oxygen to sustain life, whether they live on land or in the water. Although oxygen usually is abundant on land, the amount of dissolved oxygen in water can become low or even disappear.

In nature, dissolved oxygen levels in aquatic ecosystems occasionally are lowered by naturally occurring causes. Many types of pollution, however, are commonly the cause of oxygen depletion that results in major fish kills. Biodegradable wastes are a common type of pollution responsible for these kills. Biodegradable wastes are substances that decay or can be broken down naturally. When these wastes are put into a body of water, microorganisms (bacteria and fungi) which consume oxygen begin to decompose them. Because of an abundant "food supply" (the biodegradable wastes), the microorganisms begin to multiply, consuming large amounts of oxygen sometimes resulting in fish kills. Thus, a large amount of biodegradable waste results in very little oxygen left for fish and other aquatic animals.

Examples of biodegradable waste include effluent from sewage treatment plants, chemical plants, textile plants, paper mills, and food processing plants. Laws regulate the quality and amount of biodegradable wastes that these industries can discharge into waters. If nonpoint sources cause a problem and can be traced to a source, enforcement action can take place.

This activity investigates the effects of biodegradable wastes on the amount of oxygen present in an aquatic ecosystem. Milk will represent the biodegradable waste, yeast will represent the microorganism, and methylene blue (a dye) will indicate the oxygen supply. The methylene blue will change from blue to white when no more oxygen is present in the test tubes. (The color change is actually from blue to colorless, but the white color observed is due to the color of the milk.)

VOCABULARY:

aquatic, ecosystem, biodegradable, dissolved oxygen (DO), efficiently

PROCEDURE:

1. Fill a small beaker or a baby food jar about half full of milk.
2. Clean three test tubes. Place them in a rack and label them 1, 2, and 3.

3. Use the pipette or eye dropper (there are around 15 drops to one mL) to add the amount milk and or water to each test tube shown below:

Test Tube	Milk (mL)	or	Drops	Water(mL)	or	Drops
1	2.5		37	0		0
2	1.0		15	1.5		22
3	0.2		3	2.3		35

   Before going on to the next step, check the height of the liquid in the three tubes. It should be the same. There should be exactly 2.5 mL of solution in each tube.
4. Add three drops of methylene blue to each test tube. The methylene blue is an "indicator" solution. It will change from blue to white when the oxygen in the test tube is used up.
5. Mix each tube by putting your thumb over the top and inverting it (turning it upside down) rapidly four times.
6. Prepare a sample of yeast by adding 2 mL of dry yeast to 20 mL of water in a beaker or baby food jar. Mix the yeast and water thoroughly with a stirring stick.
7. You are now ready to mix the yeast and milk solutions. Follow these directions carefully:
   - Use a clock for exact timing.
   - Mix the yeast solution vigorously with the tip of the pipette or eye dropper. Then carefully put exactly 2.0 mL (30 drops) of yeast solution into Test Tube 1. Record the exact time you add the yeast to the test tube. Mix the test tube contents by putting your thumb over the top and inverting it rapidly four times.
   - Now repeat the procedure with Test Tubes 2 and 3. Be sure to record the exact time you add the yeast to each tube.
   - Wait until the color of each test tube changes from blue to white. Record the exact time each solution turns white. (Note: the surface of each tube always will remain blue. Can you guess why?)
   - When the color change is complete, figure the total time by subtracting the time of mixing from the time the tube changed color. Report this time to the nearest minute. It may take several minutes for the tubes to change color, so be patient.
8. Check the students' results. Then have them fill in a chart similar to the one below.

Test Tube	Time of Mixing (on the minute) (A)	Time When Tube Changes Color (B)	Total Time for the Color Change to Occur (B minus A)
1			
2			
3			

Note: It usually takes about 15 minutes for a color change to occur as this activity should not be started toward the end of a class period.

EVALUATION:

1. Have the students fill out the Student Activity Sheet.

EXTENSIONS:

1. Contact local environmental groups to talk to the class about biodegradable waste.
2. Construct a compost pile for the school yard to illustrate biodegradable waste and explain how it Can work for the environment.

ORIGNAL DEVELOPMENT RESOURCES:

Welcome to the World of Water, Dauphin Island Sea Lab, P.O. Box 369, Dauphin Island, AL 36528

ADDITIONAL RESOURCES:

The Environmental Literacy Council: Dissolved Oxygen. http://www.enviroliteracy.org/

Student Activity Sheet

Name: ___________________
Date: ___________________
Period: ___________________

1. Name the life-sustaining gas "inhaled" (taken in) by microorganisms.

2. Name the main gas "exhaled" by microorganisms.

3. Where do microorganisms living in water get the oxygen they need to live?

4. Where do green plants living in water get the carbon dioxide they need to live?

5. During the experiment just performed, why did the surface of the solution stay blue?

6. Shake one of your test tubes that has "turned white." What happens to the color? Why does the color change?

7. Air is added naturally to rivers when the water goes over rapids and waterfalls. How does "shaking the test tube" prove that air is added to water when it tumbles over rocks?

8. Why is oxygen in this experiment "used up"?

9. Name the part of your experiment that represents the "sewage."

10. Name the part of your experiment that represents the "microorganisms."

11. In which test tube did you have the most sewage? ____________ The least sewage?__________________

12. Graph the results here.

Time (minutes)

24					
20					
16					
12					
8					
4					
0	.5	1	1.5	2	2.5

Milk (mL)

13. What does the line you plotted tell you about the relationship between the amount of sewage in a body of water and the amount of oxygen in a body of water?

14. What effects would dumping large amounts of sewage or other biodegradable wastes into a body of water have on the dissolved oxygen in the water?

15. List a few examples of biodegradable wastes that are put into bodies of water. What could possibly happen if the quality and amount of these wastes were not regulated?

Glass Making (Recycling)

OBJECTIVES:

Students will be able to:

1. Describe some of the processes and resources in the manufacture of glass products.
2. Describe how recycling glass is beneficial to the environment.

BACKGROUND:

Glass accounts for five to six percent of the solid waste stream generated in Alabama. Glass is 100 percent recyclable, meaning that every pound of glass bottles and jars brought to a recycling center can be used to make new glass containers. (Mirrors and tempered or tinted glass for windows cannot be recycled.)

Glass is made by heating sand, lime, soda, ash, and cullet (crushed glass that has been collected for recycling) to a very high temperature until the mixture melts. As it cools, it is poured into molds and injected with air.

All bottles and jars were once made by glass blowers who blew bubbles with the molten glass mixture and formed them into shapes that hardened as they cooled. Today's manufactured bottles and jars are formed by injecting air into the molten glass mixture within molds.

The following activity simulates the making of glass, substituting sugar for sand, lime, and ash. This activity also simulates the common process of making plastic products called "blowmolding." The students may also be interested to know that "sugar glass" is used in movie-making for "breakaway" windows and bottles.

VOCABULARY:

heat, energy, natural resources, refuse, recycle, cullet, minerals

Grades:

6-8

Subjects:

Science, Art, Social Studies

Time Needed:

Two 45-minute periods

Materials:

transparency of "Glass Manufacturing" illustration
an overhead projector
variety of glass objects (different shapes, colors, and function)
1 cup (50 g) sugar
hot plate
metal pan
8 x10 (20 cm x 25 cm) piece of glass from a picture frame
cup of water(12 mL)
newspaper
safety glasses
tongs or hot pad
For each group:
- one wide-mouth glass jar
- one stiff straw or glass tubing
- balloon
- rubber band

PROCEDURE:

Setting the Stage

1. Make an overhead transparency of "Glass Manufacturing."
2. Hold up a glass object. Ask: Is this glass a solid or a liquid? Tell them glass is a liquid that has been cooled to form what appears to be a solid. Although it seems solid, glass remains a liquid. Have the students touch the glass objects and describe the colors, shapes, and textures. Ask them what uses the many kinds of glass objects have. Hold the objects to the light and show how some reflect light, some are clear, and others are opaque.
3. Display the "Glass Manufacturing" illustration and explain to students how glass is made, emphasizing the heat and energy required during the process. Explain that the minerals are taken from the ground and heated to very high temperatures to make them melt. This process requires enormous amounts of energy. The supply of minerals and energy used to make glass is limited, so we should not throw away glass.

4. Explain that glass jars can be remelted to make new glass, so these natural resources can be recycled. Ask students why recycling glass is good for the environment. (Recycling glass reuses the natural resources that are in limited supply, and it saves energy.)
5. Tell the students that Alabamians throw away most of the glass used in packaging. Ask where the glass goes when it is thrown away. Explain that there is no such place as "away" and that all trash has to go some place. Tell the students that place is called a landfill. Explain that space in landfills is growing scarce because of how much we throw away. We should try not to throw away so much trash. Ask if anyone knows how to teach people not to throw away their glass.

Activity

*Note:*Remind the students to practice good safety habits during this procedure.

1. Start heating the water. Tell the students you are going to make "pretend" glass using sugar in place of the real materials. Let students examine the sugar and describe it terms of color, texture, shape, and taste. Point out that the minerals used to make real glass are similar, but they come from the ground.
2. Ask a student to describe sand. Have the student describe the water and the changes in it as the heat begins to make it boil. Pour the sugar into the boiling water. Tell the students to pretend the sugar is the minerals from the ground (sand, limestone, feldspar). Stir the mixture vigorously over the heat until the sugar is dissolved (about 5 minutes).
3. Ask students to describe the changes in the sugar and water. Tell them this is how glass looks before it cools. Put several layers of newspaper under the sheet of glass. Carefully pour the mixture onto the sheet of glass and allow to cool (about 15 minutes). Proceed to the molding glass experiment.
4. Hold up the two sheets of "glass" so students can see through them. By allowing it to set overnight, the "glass" will become frosted. On the next day, ask the students to describe the changes that occurred overnight.
5. (Optional) To illustrate the recycling of glass, scrape the dried "glass" back into the pan (call it "cullet," small pieces of crushed, recycled glass); add water and reboil. More sugar will have to be added to repeat the procedure. Ask the students which resources were replaced when the cullet was used to make the new glass (minerals, energy).

Molding Glass:

1. Divide the class into small groups of 4-6 students. Give each group a wide-mouth jar.
2. Give each student a straw or glass tubing, balloon, and rubber band.
3. Attach the balloon to the straw with the rubber band.
4. Have the students take turns putting their balloon into the jar and blowing it up until it takes the shape of the jar.
5. Explain that this process illustrates how glass is molded into being a jar or other shape.

EVALUATION:

1. Ask the students to name some of the processes and natural resources used to manufacture glass. Students may illustrate the process, labeling the "natural resources" used to make glass and showing which ones are replaced when recycled glass (cullet) is used as a raw material.

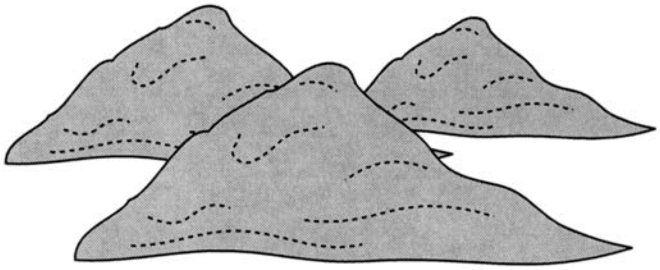
EXTENSIONS:

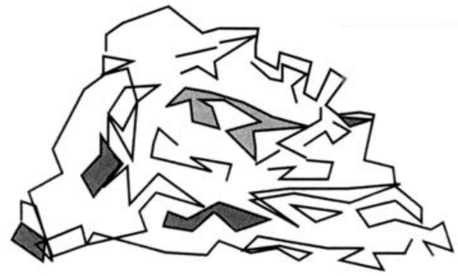
1. Bring samples of handmade glass to class and show students the bubbles in the glass formed by a person blowing air into the hot glass mixture. Point out the irregularities that show the glass was handmade.
2. Have students research innovative uses for recycled glass such as "glassphalt" and insulation.
3. Invite a glass blower to class to explain the techniques and to demonstrate the art.

ORIGINAL DEVELOPMENT RESOURCES:

Glass Packaging Institute, 1627 K Street, NW, Suite 800, Washington, DC 20006 www.gpi.org

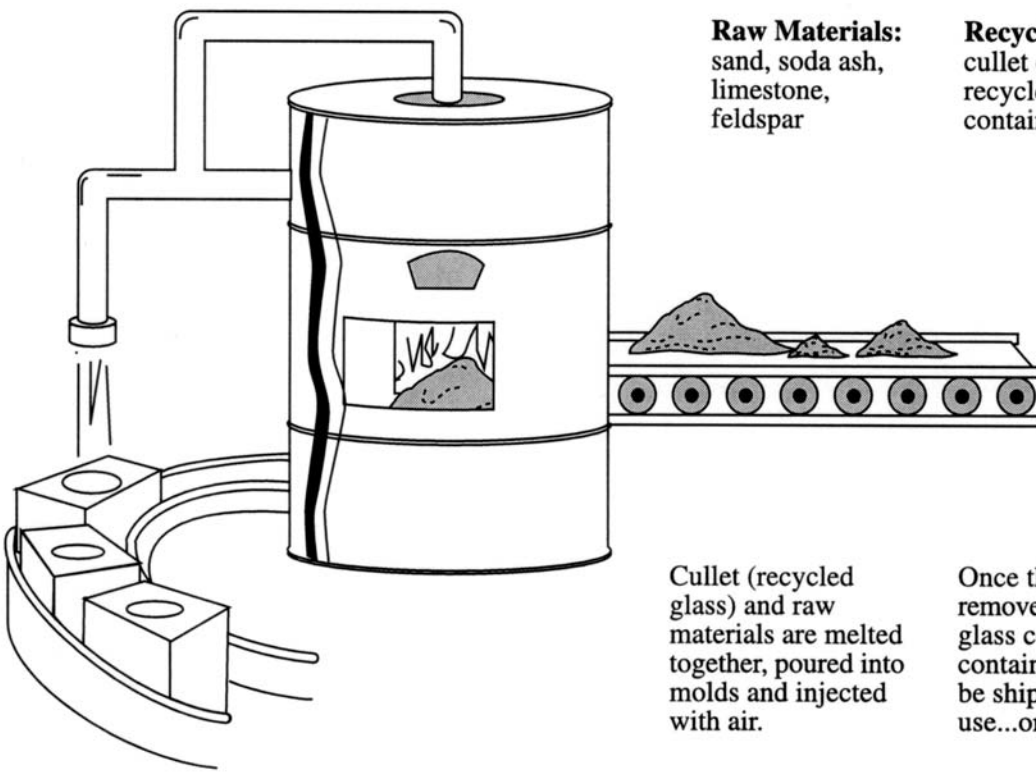
Glass Manufacturing





Raw Materials:
sand, soda ash, limestone, feldspar

Recycled Materials:
cullet or glass to be recycled into new containers



Cullet (recycled glass) and raw materials are melted together, poured into molds and injected with air.

Once the mold is removed and the new glass cools, a new container is ready to be shipped for use...or reuse.

1,330 pounds (603 kg) of sand, 433 pounds (196 kg) of soda ash, 433 pounds (196 kg) of limestone, 151 pounds (68 kg) of feldspar and 15.2 million Btus of energy are required to make just one ton of glass. Major deposits of white sand suitable for making glass are found in Illinois, New Jersey, the Alleghenies and the Mississippi Valley. Most soda ash comes from Wyoming, and 65 percent of the feldspar in the United States comes from California and North Carolina.

Different colored glass is produced by adding small amounts of other substances such as iron, copper, and cobalt. Green glass is made by adding iron.

Notes

Hide & Seek: Hazardous Waste On The Move

OBJECTIVES:

Students will be able to:

1. Identify household products that are potential water pollutants.
2. Describe how pollutants move into ground or surface water.

BACKGROUND:

Wastewater from inside and outside the home ends up in the environment and becomes part of the natural water cycle. Many household products can contaminate the water supply if we don't dispose of them properly. There are many environmentally friendly substitutes for many of the household products used in homes today. Highly treated wastewater called "reclaimed" water is suitable for irrigation and industry uses. This reduces the amount of water pumped from the aquifer.

VOCABULARY:

hazardous waste, wastewater, aquifer

ADVANCE PREPARATION:

1. Select household hazardous waste products.
2. Prepare all materials ahead of time.
3. Food coloring represents pollutants.
4. Bread represents soil.
5. Sprayer represents rainwater.
6. Select a waterproof work area.

Grades:
6-8

Subject:
Science

Time Needed:
40 minutes

Materials:
insect killer
rug and upholstery cleaner
oven cleaner
disinfectant cleaner
drain opener
toilet bowl cleaner
chlorine bleach
spot remover
gasoline
paint thinner
degreasers
hazardous waste activity sheet
red food coloring
one slice of bread
spray bottle
water

PROCEDURE:

Setting the Stage

1. Discuss with the students how we get safe drinking water.
2. Discuss the chemical name for water (H_2O).
3. Discuss with the students how they feel about household hazardous waste products in their homes?
4. Show students a slice of bread representing a side view of the soil.
5. Drop one drop of red food coloring at the top crust edge of the bread slice to represent the leftover household cleaner you poured out.
6. It starts to rain (spray water on food coloring). Allow water and food coloring to seep through the bread. It then becomes difficult to locate where the pollution originated.
7. Ask the students the following questions.
   - What happened?
   - What can you tell about the wastes in our surface water? Our drinking water?

Activity

1. Show students household hazardous waste examples such as listed in materials list.
2. Distribute the "Toxic Products in my Home" activity sheet.
3. Divide the group into teams; have them record their discoveries from their homes on the activity sheet.
4. Categorize each household product.
5. Have each team report its findings to the class.

Follow-Up
1. Ask students to discuss their findings.
2. What did they learn from this experience?

EXTENSIONS:
1. Make a poster of hazardous waste product labels found in the home.
2. Interview parents or adults on how they feel about these products.
3. Many product labels state “Dispose properly” but they don’t say how. Have students call the toll-free number on the label if oine is listed. Have the students request information about proper disposal of the product.

ORIGINAL DEVELOPMENT RESOURCES:
4-H Water Wise Guys. (1992). Gainesville, FL: University of Florida Press.

ADDITIONAL RESOURCES:
United States Environmental Protection Agency: Superfund. Found at: http://www.epa.gov

Toxic Products In My Home

Name: ____________________

Date: _____________________

Period: ____________________

Product	Toxic	Location	Proper Disposal
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Notes

Ins And Outs Of A Worm's Life

Grades:
6-8

Subjects:
Science, Math

Time Needed:
Extensive ongoing project

Materials:
wooden box (24" x 42" x 16")
(61 cm x 106.5 cm x 40.5 cm)
paper
water
dirt
redworms (*Eisenia foetida*) calcium carbonate (egg shells)
food waste (no meat or meat by-products)

Although construction plans for the box are included with this lesson, alternatives include using a polystyrene ice chest or an apple crate with a screen covering the inside of the box or any container in which you can drill holes.

OBJECTIVES:

Students will be able to:

1. Discover a beneficial, low-technology way to reduce household waste.
2. Explain the natural process of biodegradation and soil production.
3. See how to improve soil through worm composting.
4. Describe the benefits of composting.

BACKGROUND:

When we throw food scraps into the garbage, we turn a resource into a liability. At significant financial and environmental cost, waste has to be picked up, transported, and landfilled or incinerated. Composting kitchen waste provides an alternate use for kitchen waste and creates rich soil.

Redworms, *Eisenia foetida*, can be used to process kitchen waste in backyard worm bins into high-quality garden compost. ***Note:*** Properly constructed and maintained, worm bins do not give off an offensive odor. For more information on earthworms, see the article "Getting Earnest About Earthworms," by Richard Conniff, *Smithsonian Magazine*, July 1993.

Worm bins provide the following benefits:
Reduce household waste
Save garbage disposal costs
Produce an excellent soil amendment
Provide worms for fishing
Demonstrate one of the most important natural processes: biodegradation and soil production.

VOCABULARY:

anaerobic, worm castings, biodegration, composting

PROCEDURE:

Setting the Stage

1. Make copies of the 3 bin construction worksheets included in the lesson.

Activity

1. Ask the school's shop class or parent volunteer to build the wooden box to specifications included with the instruction sheet. OPTION: Select a similar sized alternative box such as an apple crate or heavy shipping carton. You can use wood, metal, or other containers if they are not filled deeper than 12 inches. A piece of heavy-duty black plastic may be used as a cover. Half-size bins are also effective; they require half the amount of food and materials. (Since worms do not react to red light, a red Plexiglas side panel or lid would allow direct observation of worm activity.)

2. Discuss with the class the impact of food wastes on the solid waste stream. Discuss alternative methods of handling food wastes. Introduce the idea of using redworms (*Eisenia foetida*).
3. You will need one pound (454 g) of redworms for the bin. Ask the students to look for and collect redworms (not nightcrawlers). Hints for where to look: in barnyards, under mulch, in compost piles, under decomposing lumber. You may need to supplement the redworms found by obtaining some from a commercial grower. Look in the *Yellow Pages* under Agricultural Suppliers or Bait Shops.
4. Set up your worm bin. For a 4-cubic-foot (1-cubic-meter) bin, bury four pounds of food waste in the bin each week, making sure to rotate the location of the burial (mentally dividing the bin into nine squares would probably be helpful).
5. Generally, *for each cubic foot (cubic meter) of worm bin*, you need 1.5 pounds (680 g) of paper as bedding, 1 gallon (3.5 liters) of water, 1 pound (454 g) of garbage per week, 4.5 ounces (128 g) of redworms, a bit of soil, and calcium carbonate. For a 4-cubic-foot (1 cubic meter) worm bin, you will need:
   - 1 box filled no deeper than 12 inches (to prevent anaerobic conditions from developing)
   - 1 room or space with a temperature between 55 degrees F and 77 degrees F (13 degrees C and 25 degrees C)
   - 6 pounds (2.7 kg) of paper for bedding
   - 1-2 handfuls of soil (optional)
   - Several eggshells
   - 1 pound (454 g) of *Eisenia foetida* (redworms)
   - 4 pounds (1.8 kg) of food waste per week
6. Shred the paper by tearing it into strips about 2 inches (5 cm) wide. Put the paper in a bucket, and slowly pour in water while fluffing the paper occasionally. Let the paper segments drip until the dripping subsides. Put wet strips of paper into the worm box, and sprinkle in several eggshells (for worm reproduction).
7. Gently place the worms in the box, leaving the top open until the worms burrow down. Close the lid or cover with a black plastic sheet. Bury food in the box each week, rotating the burial location. Some of the foods that will work well in the worm bin are bread, corn stalks, egg shells (a good source of calcium carbonate), grass clippings, leaves, saw dust, spoiled fruit and vegetables, vegetable peelings, clothes dryer lint, citrus rinds, evergreen needles, hay or straw, twigs, weeds, coffee grounds, discarded houseplants and flowers, manure, garden waste, hedge clippings, used potting soil, and wood chips. Avoid putting plastic, bottle caps, rubber bands, sponges, aluminum foil, or glass in the box. Fruit flies can be avoided by burying the food waste completely.
8. The worm bin needs little routine maintenance. Depending upon the desired outcome, the bedding should be changed every three to six months. After three months, the number of redworms is high; after four months, the number of redworms will still be high, and the quality of compost will be fairly good; after six months, many redworms will have died, but the quality of the compost will be very good. The resulting compost will be primarily worm castings (worm manure).
9. To change worm bedding, either dump the contents of the bin under a bright light and brush away the layers of compost (*the worms will move away from the light and gather at the bottom of the pile*); or pull the compost plus worms to one side of the bin and add new bedding to the vacant side.
10. A simple alternative is to use only one-half of the box at a time; put your bedding and worms in one side of the worm bin. Continue to bury food into the bedding until it is composted. Then add new bedding to the empty half of the bin. Begin burying food on the new side.
11. Allow one month for the worms to migrate to the new side. Remove the worm castings. Repeat the process. To be certain you have all the worms from the first side, expose the worms to bright light and wait 20 to 30 minutes. Remove the top layer until worms are exposed. Repeat until the worms are in a mass in the center of the old bedding. Use the soil formed by the castings on potted plants or in the garden.

EVALUATION:

Students should answer the following questions:

1. What are worm castings?

2. How many ounces or pounds of worms, bedding, water, and food waste do you need for each cubic foot of a worm bin?
3. How are the food wastes being reduced (recycled) by the worms?

EXTENSIONS:

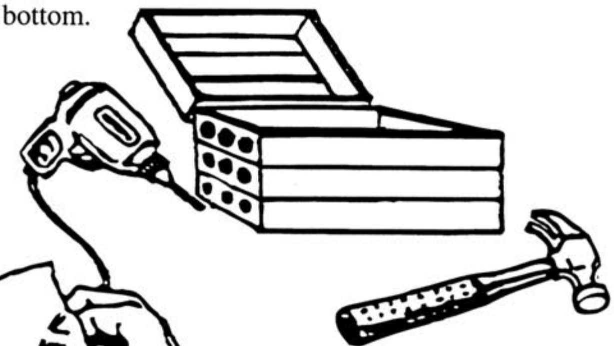
1. Study the reactions of worms to different colors of light.
2. Study the food preferences of young versus mature worms.
3. Using four worm bins, study the reactions of the worms to the four food groups.
4. Study the other organisms present in the worm bin. What are the interrelationships of these organisms?
5. Study the effects of various mixtures of vermi-compost, peat moss, soil, and perlite on potted plants.
6. Calculate how much food the households of class members throw away in a day. Base the calculation on the fact that each Alabama resident produces about 4.5 pounds (2 kg) of garbage in the home per day.

ORIGINAL DEVELOPMENT RESOURCES:

South Carolina Health and Environmental Control, used with permission.

Worm Composting Bin

1. Build or obtain a container.
Drill holes in 2 sides and on the bottom.



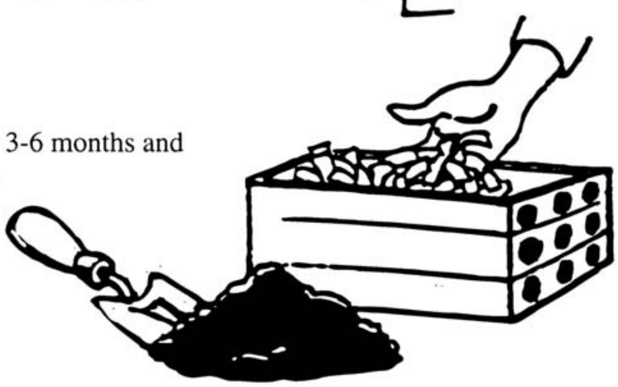
2. Shred paper for bedding.

3. Wet the bedding and squeeze out excess water.

4. Sprinkle in 1 or 2 eggshells.

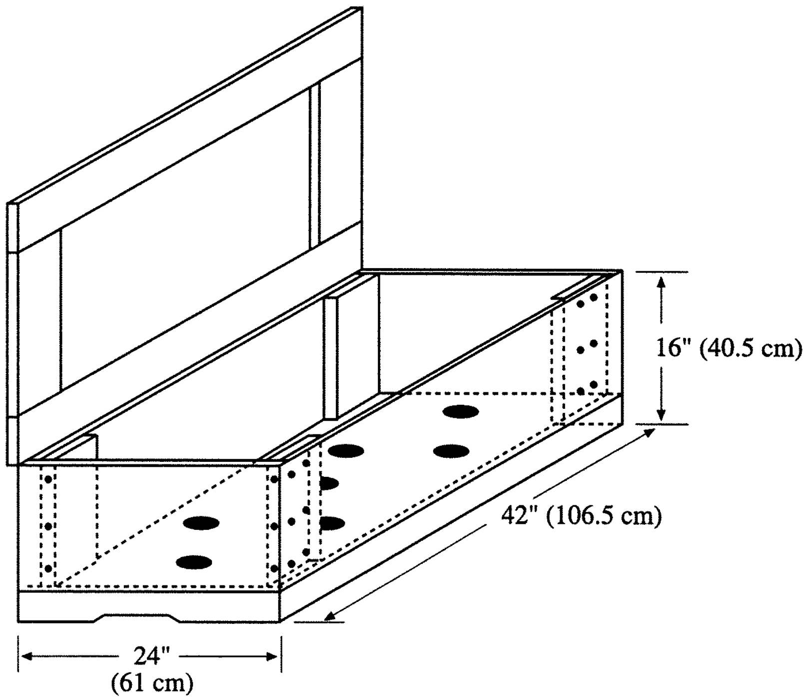
5. Place worms in box.

6. Bury garbage for food once a week. (Be sure you rotate the placement of the garbage.)



7. Change the bedding every 3-6 months and remove the newly made soil.

1-2-3 Worm Composting Bin



This system is designed for composting vegetable food wastes using red worms. Food wastes and worms are "bedded" in shredded and moistened newspaper, cardboard, peat, or brown leaves. The worms turn both food wastes and bedding into a high-quality compost suitable for use on house plants, seedlings, or general garden use.

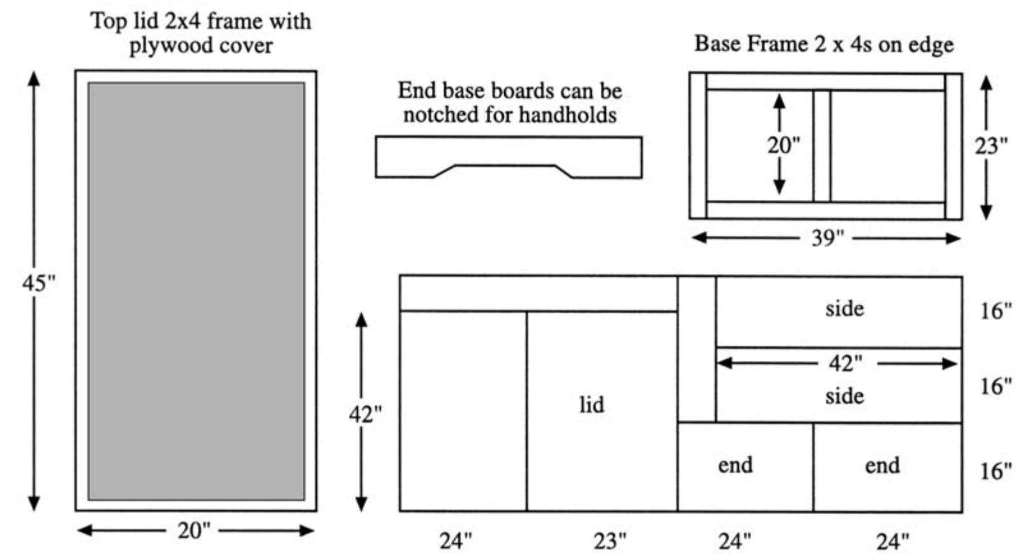
To maintain this system, simply rotate food wastes throughout the bin. Every 3-6 months the compost should be moved to one side of the bin and new bedding added to the empty half. At this time, start burying wastes in the new bedding only. Within one month, worms will populate the new bedding; finished compost then may be harvested and the rest of the bin can be rebedded. During the winter, worm bins should be kept in a cool indoor space, such as a basement or warm garage, to avoid freezing. A properly maintained worm bin is odorless. Bins may be placed in a shady outdoor space the remainder of the year. Flies may be controlled by placing a sheet of plastic over the bedding.

This bin can be built for about $35 with new wood and hardware or less using recycled materials. Worm bins can also be made from wooden boxes or other containers. Any worm bin must have drainage in the bottom and a tight fitting lid to keep moisture in and pests out. A starter batch of worms can be purchased at a small additional cost, or find some in an old compost pile.

Materials
one sheet of treated 1/2" (1.3 cm) plywood
one 12 foot 2" x 4" (3.7 m x 10 cm)
one 16 foot 2" x 4" (5 m x 10 cm)
2 lbs. (9 kg) of 6d galvanized nails
1/2 lb. (2 kg) of 16d galvanized nails
2 galvanized door hinges

Tools
Tape measure, skill saw or rip hand saw, hammer, saw horses, long straight edge or chalk snap line, screwdriver, and drill with 1/2" (1.3 cm) bit.
Use eye and ear protection.

Construction Details



Measure and cut plywood as indicated in drawing above. Cut the 12 foot 2" by 4" into five pieces: two 39", two 23", and one 20" long. Nail the 2" x 4"s together on edge with two 16d nails at each joint as illustrated in the Base Frame diagram. Nail the plywood base piece onto the 2" x 4" frame.

Cut four 1-foot lengths out of the 16 foot 2" x 4". Take each plywood side piece and place a one-foot 2" x 4" under each of its ends so that the 2" x 4" is flush with the top and side edges of the plywood, and nail the boards into place. Nail the side pieces onto the base frame. To complete the box, nail the ends onto the base and sides. To reinforce the box, be sure there is a nail staggered at least every 3 inches wherever plywood and 2" x 4"s meet. Drill twelve 1/2" holes through the bottom of the box for drainage.

To build the lid, take the remaining 12-foot 2" x 4" and cut it into two 45" pieces and two 20" pieces and lay them flat, short pieces on the inside as indicated in the diagram above, so that the plywood top is inset from the edges of the 2" x 4" by 1-1/2" all the way around the perimeter. Nail the plywood onto the 2" x 4"s and on the underside of the 2" x 4" lid frame, so that the lid will stand upright when opened.

Is It A Waste? What's The Appeal?

Grades:
6-8

Subjects:
Science, Social Studies, Mathematics, Language Arts, Marketing, Environmental Education

Time Needed:
One class period

Materials:
samples of advertising from newspapers and magazines
coupons for the same product but with different name brands and types of packaging.

OBJECTIVES:
Students will be able to:
1. Identify ways that advertisements are used to sell products.

BACKGROUND:
In 1974 the Environmental Action Foundation published research showing that the energy used to produce the packaging used annually by a major fast food restaurant chain was equal to the amount of energy required to supply the people of Boston, Washington, San Francisco, and Pittsburgh with energy for a year. This major chain and other chains have changed their packaging strategies to use less Styrofoam and to use more recycled content paper. Ask students if they think the changes in packaging will use less energy and will reduce waste.

VOCABULARY:
advertising, marketing, band wagon

PROCEDURE:
1. Display various advertisements. Have the students discuss:
   - Which product would you buy? Why?
   - What is advertising? What is the purpose of advertising?
   - Does advertising influence what you buy? How?
   - Which advertisement do you like best? Why?
   - Do your reasons have anything to do with the quality or function of the product?
   - Do you purchase name-brand items instead of generic items? Why?
2. Discuss ways in which products are promoted on television, on radio, and in print. Analyze at least 25 ads. Note the following:
   - What strategy does the advertiser use to sell the product?
   - What is the advertisement really selling: convenience, health, sex appeal, status, fun, quality?
   - Does the advertisement mention the packaging?
   - Is the packaging reusable or recyclable?
   - Does the ad suggest what you should do with the packaging?
3. Design a chart to help analyze characteristics of these ads. A sample follows. Feel free to add other categories.
4. Make a composite chart that shows the results of all the surveys done by students. Discuss:
   - What usually happens to the packaging?
   - Do you think the manufacturer of the product should be responsible for what happens to the packaging once the product is used? Why or why not?

Name of Product	Television	Radio	Print (magazines, newspapers)	Status	New and Improved	Convenience	Sex Appeal	Symbols	Self-Image	Famous People	Flashy Packaging	Band Wagon	Vague Pronouns	Keeping Up With the Joneses

EVALUATION:

1. Name three reasons you buy one type of packaged product instead of another.
2. How often are your reasons based on the quality or function of the product?
3. Discuss ways in which advertisements may influence what you choose to purchase.

EXTENSION:

1. Check the products bought by your family and examine the packaging for appeal, convenience, and environmental impact.

ORIGINAL DEVELOPMENT RESOURCES:

Used with permission from Recycling Study Guide, Bureau of Information & Education, Wisconsin Department of Natural Resources, 1989.

Life Cycle Of A Taco

Grades:
6-8

Subjects:
Science, Geography

Time Needed:
Two 50-minute periods

Materials:
handout of the Life Cycle inventory
large index cards
Provide a varied assortment of
consumer products and/or containers manufactured from a wide range of raw materials:
- aluminum soda can
- newspaper
- food products with packaging
- disposable diaper
- clothing made from natural and synthetic materials

OBJECTIVES:
Students will be able to:
1. Break down the components of producing a product.
2. Create a life cycle analysis of a taco.
3. Trace a product through its life cycle by starting with the finished product.

BACKGROUND:
Buying and using products that result in less garbage is one aspect of source reduction or waste prevention. Life cycle analysis gives a more complete picture of the waste and energy associated with a product. Rather than just looking at the amount of waste that ends up in a landfill or an incinerator, the analysis measures energy use, material inputs, and waste generated from the time raw materials are obtained to the final disposal of the product. The product is evaluated through each of the following six stages of the life cycle.

acquiring the raw materials
manufacturing and processing
distribution and transportation
use/reuse
recycling
disposal (waste management)

Each stage receives inputs of materials and energy and creates outputs of wastes. Overall, these stages may have a significant environmental impact. This activity uses a game to introduce students to life cycle analysis.

VOCABULARY:
life cycle analysis/assessment, waste, raw material

ADVANCE PREPARATION:
1. The teacher should have a large room with the desks placed in a circle.
2. Obtain a varied assortment of consumer products and/or containers manufactured from a wide range of raw materials. Place these materials in the center of the circle.
3. Discuss the Life Cycle Inventory handout.

PROCEDURE:
Setting the Stage
1. Introduce the concept of life cycle analysis. Lead students through the life cycle of a product, beginning with raw material acquisition and ending with disposing of the product. Along the way, give various examples of how energy is consumed and how waste products (air emissions and solid waste) are produced.
2. Inform students they will be retracing the life cycle of a product from its disposal to its raw materials' source.

3. Instruct students to sit in a circle. Place the objects you have brought to class in the center, designated as

the "waste stream," where the product is finally disposed.

Activity

1. General Product Life Cycle Analysis: One student will select an object from the waste stream. Beginning with the student who selected the object and moving clockwise around the circle, have students tell a life cycle story about the product with each student building on the previous student's statement. The first student starts with raw materials. The rest work through transportation, manufacturing and processing, packaging, consumer purchase, use, and disposal. (It may be helpful to write the steps on the chalkboard.)
2. Taco Life Cycle Analysis: The teacher should display the six product life cycle stages. Hand the students numbered index cards, from which they can read the following descriptions in order to trace the product life cycle stages. The teacher should start by saying, "Let's take a look at all of the preparation that goes into serving a taco."
   - Grain is grown, using a variety of fertilizers, herbicides, pesticides, and significant quantities of water. Threshers, combines, and tractors are used to sow, grow, and reap the grain. All of these large pieces of equipment burn fuel and emit pollutants and greenhouse gases.
   - The grain is shipped to cattle ranches or feedlots where it is fed to cattle together with water. Waste products include manure, methane, and uneaten grain.
   - Cattle are shipped by truck or train to market, where they are fed and sold. They are shipped again to processors. At the processing plants, the cattle are slaughtered and cut into large sections called primal cuts. These must be quickly refrigerated and aged. Waste products include unusable animal parts, waste water, and manure.
   - The beef is shipped in refrigerated trucks and rail cars to food service warehouses where it is ground, formed into ground beef, and boxed and wrapped for use. It is stored and frozen until needed. The beef is shipped by freezer truck to stores and restaurants and is kept in cold storage until needed. Then it is prepared by cooking the meat in a pan or grill.
   - Grain is grown for use in baking. Vegetables are grown: producing tomatoes, onions, and lettuce. All use fertilizer, pesticides, and herbicides plus large quantities of water. Farm machinery that uses fuel and some chemicals is used.
   - Grain is shipped to mills where equipment converts it into flour. The flour is packaged in bulk bags. Vegetables are shipped to refrigerated warehouses and held in storage until needed. Then they are sent by refrigerated trucks to stores and restaurants where they are cut up, cooked, and served. Some tomatoes and onions are shipped to processing companies.
   - The flour is shipped to bakeries where it is mixed with water and other ingredients. The dough is then baked in ovens, which require heat energy in the form of gas, oil, electricity, or wood. Once cooled, the tortillas are packaged and warehoused. Condiments also are packaged and shipped to warehouses. Then they are shipped to local stores. Waste includes leftovers, which are thrown away. The tortillas are trucked to local stores where they are used to make tacos.
   - Trees are cut and oil or gas is drilled. The lumber and petroleum are shipped or piped to mills and refineries. At the mill, lumber is pulped, using very large quantities of water and corrosive chemicals including chlorine. Large machines then turn the pulp into paper, which is wound on rolls and stored.
   - The paper and plastic are shipped to manufacturing plants, which make a variety of products: polycoated paper for use in wraps and boxes; paper for use in bags; plastic wrap for use in bread, meat, and vegetable packaging; and cardboard for use in pallets and boxes. Finished packaging is shipped to points where it is needed. Wastes include most, if not all, of the used packaging including wrap used to provide a freshly cooked, sanitary taco. The beef is then placed on a flour tortilla topped with condiments, wrapped, and put under hot lights until served. Uneaten portions are thrown away.

Follow-Up

1. Have the students discuss and summarize the life cycle analysis. Questions might include:
   - What inputs and outputs resulted from manufacturing this product?
   - Are all the outputs equal in terms of environmental effects?

- What were the environmental effects and could any be minimized?
- What other resources were consumed as a result of this product's manufacture and distribution?
- Do you see how using less has a huge impact throughout a product's life?
- Will you look at products differently now?
- What considerations do you now have as consumers that you did not have before?
- Where does the real waste occur in the production of tacos?

EXTENSIONS:

1. Ask students to select a favorite item, research it, and then write or illustrate a life-cycle analysis about it. If possible, have them contact manufacturers for information.
2. Have the students draw their own life cycle posters.
3. Have the students work in small groups to research a business to learn its operation philosophy, manufacturing approach, environmental position, research and development activities, and special problems relating to its industry including waste management.

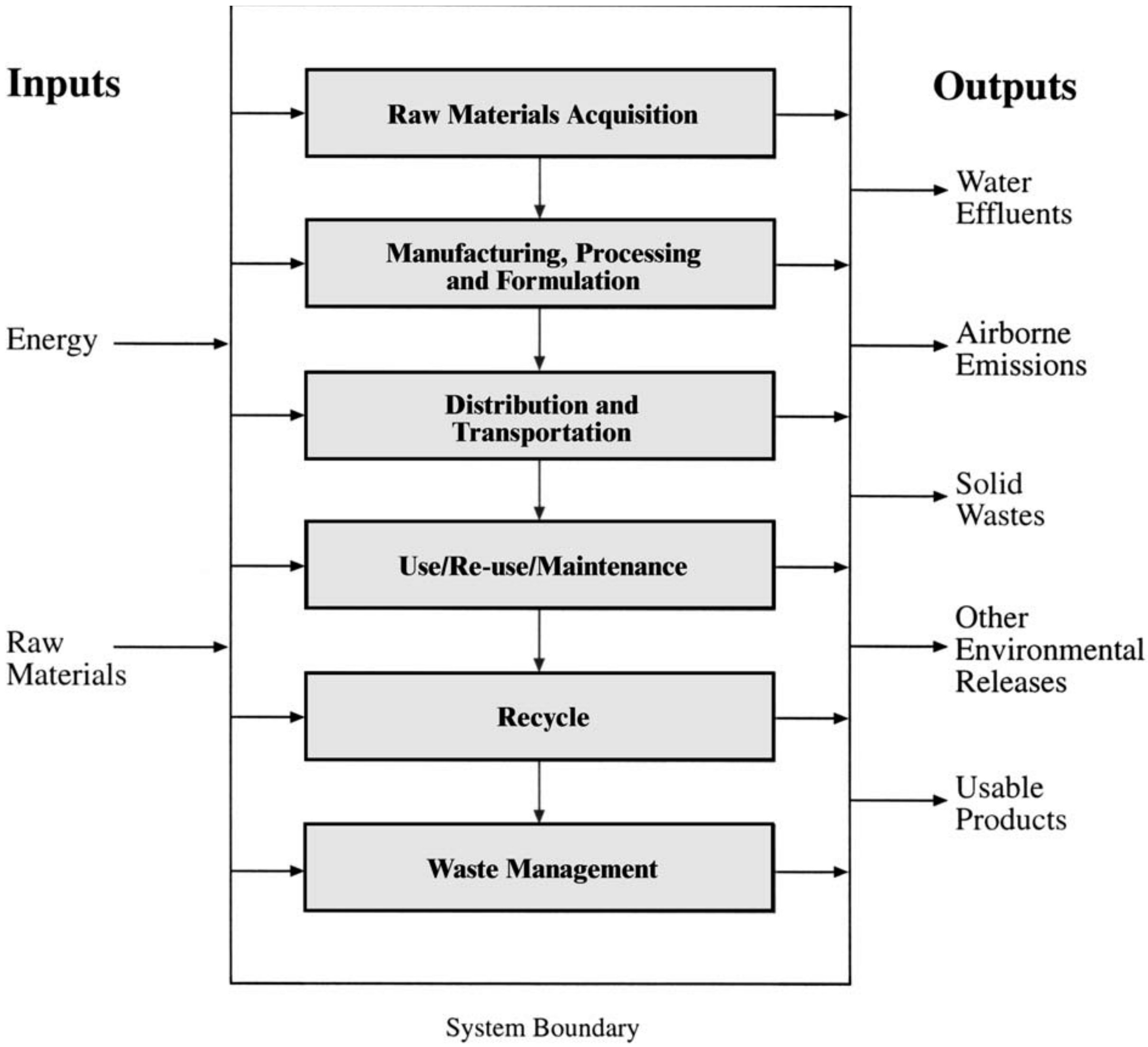
ORIGINAL DEVELOPMENT RESOURCES:

An ounce of prevention. Midland, MI: Dow Chemical Company.

ADDITIONAL RESOURCES:

The Environmental Literacy Council: Life Cycle Analysis

Life Cycle Inventory



Paper Recycling And By-Products

OBJECTIVES:

Students will be able to:

1. Make recycled paper to see and understand the by-products of the process.
2. List ways that by-products of the paper manufacturing process typically pose potential environmental concerns.

Grades:

6-8

Subjects:

Science, Social Studies, Art

Time Needed:

Several class periods

Materials:

several sheets of different types of used paper (newsprint, white office paper, construction paper, envelopes)
nylon stocking,cheesecloth or millipore filter
blender or egg beater and wide-mouthed container
pans
large mixing spoons
cups to scoop with
blotters
screen made from window screen and wood frame
sponges or towels to soak up water
warm water
a place to dry paper overnight
iron (to help dry paper)
litmus paper or pH test kit

BACKGROUND:

Paper cannot be recycled indefinitely because the fibers eventually break down. However, many grades of paper can be de-inked, cleaned, and bleached. These are processes that allow paper to be reused as game boards, tissue paper, ticket stubs, packaging, covers for books, insulation, and animal bedding. In Alabama there are three mills that recycle the newspaper fibers for uses other than newsprint. They are Gulf States, Paper Corporation in Demopolis, Weyerhauser in Pine Hill and Cell-Pak, Inc. in Decatur.

Although recycling paper saves natural resources and energy, pollution problems still exist in the production of recycled paper. To be recycled into many grades of paper, waste paper must have contaminants removed.

Black printing inks used in newspapers are composed of about 30 percent pigment (usually carbon black) and about 70 percent refined oil. Colored pigments in magazines—and increasingly in newspapers—contain heavy metals.

New low-rub inks and laser printing cause additional problems because they are difficult to remove from paper.

The paper-making process requires large amounts of water, which must be cleaned of contaminants. The remaining paper sludge also must be disposed of properly because petroleum distillates and heavy metals can remain present in this material. Both the contaminated water and sludge must be treated in a wastewater treatment plant before being released into the environment.

VOCABULARY:

pH, contaminant, by-product, heavy metals, distillates, wastewater treatment, .de-inking, pulp, slurry

PROCEDURE:

1. Divide the class into small groups and have each group make recycled paper out of a different type of waste paper using the “making Recycled Paper” instructions.
2. While making paper, students should collect the water that drains through the screen while the paper is bring pressed to check it for pollutants. Have each group strain the collected water and sludge through a filter and examine what contaminants remain.
3. Have the students test the collected water after straining and note the pH, color, and sediment present. Set

the samples aside (do not disturb) and note pH, color, and sediment after 24 hours.
4. Have each group complete the “Questions about Recycled Paper and Its By-Products” and discuss the results as a class.

EVALUATION:

Ask the students to write the answers to these questions:
1. What natural resources are conserved when paper is recycled?
2. What kinds of paper can be recycled?
3. Does recycling solve all paper solid waste problems?

EXTENSIONS:

1. Visit or write an Alabama paper mill. Find out if the mill uses only virgin timber, a mixture of virgin timber and recycled paper, or only recycled paper. Research the pollution control methods used in paper-making plants.
2. Research the new soy-based inks and their effect on paper recycling.
3. As an art project, make recycled paper from various types of used paper such as colored construction paper, white office paper, or brown paper bags. Students may also add bits of leaves, grass, flowers, pinestraw, and other natural elements.

ORIGINAL DEVELOPMENT RESOURCES:

www.papercoalition.org/PaperFactSheet.pdf

www.prwg.com/papermaking

Grummer, A. Complete guide to easy papermaking. ISBN 0-87341-710-0

Grummer. A. Let’s make paper- classroom kit. Available for ordering through www.prwg.com.

ADDITIONAL RESOURCES:

Paper Recyling Coalition: http://www.paperrecyclingcoalition.com

http://arnoldgrummer.org

Conservatree. Found at: http://www.conservatree.org

Questions About Recycled Paper and Its By-Products

1. What materials are in the sediment and sludge?

2. What is causing the discoloration of the water?

3. Is the strained water less polluted than the unstrained water? Why?

4. Should the remaining paper sludge be treated as solid waste or hazardous waste?

5. How can we reduce pollution problems from the making of recycled paper?

The Emerging World of Deinking

excerpts from the article that appeared in Waste Age. June 1992

Whether by floating, washing, or exploding, the technology to remove ink from waste paper is flourishing in the U.S.

As more and more waste paper is collected by U.S. recycling programs, paper mills are having a hard time keeping pace. Despite many commitments across the country to recycle paper with new deinking facilities, the demand for waste paper has been unable to keep up with supply. That's one of the main reasons prices for waste paper are dismal.

Mills do have the technology to handle the waste paper. Complete deinking technologies have developed at a rapid pace in recent years, and the paper industry promised 9.3 million tons of (annual) deinking capacity in North America by 1995. Processing that capacity will require some form of the two most common deinking technologies at the heart of it all: flotation and washing. Steam explosion technology and other methods for deinking are gaining momentum - with many pilot programs proving successful - but they have yet to be used in large-scale commercial production of deinked pulp.

Flotation deinking is self-describing. Ink is literally floated off paper and out of a pulp slurry.

An extensive series of steps

Bowater, a major newsprint producer in the southern U.S., brought a flotation deinking machine on-line in Calhoun, TN, in 1991. The $67 million facility uses about eight broad steps to deink 380 tons per day of old newspapers (ONP) and old magazines (OMG) to produce 300 tons per day of clean secondary fiber.

Mills recently began mixing in OMG because they found the clay content helps in the flotation stage. Magazine paper uses clay to help smooth the paper surface and create an optimum surface to which glossy inks can adhere. Mills that use flotation but include no OMG add clay or other fillers directly. The most common mixture of ONP and OMG is a 70/30 percent mix, although some mills vary the percentages based on what they want to accomplish.

Clean ONP and OMG ride a conveyor to a drum pulper or a hydropulper. Bowater's pulper throws a slushball on ONP, OMG, and water around for about 20 minutes. This action serves to break apart the paper by slowly deteriorating all the bonds holding the paper together.

The unique rotating ability of the drum not only ensures a good tossing but, after time, works the paper to one end where tiny slots wait to begin the first of many filtration steps. Pulp and water drain through these one-millimeter holes, leaving behind large undesirables such as plastics, wire, labels, and "stickies." Stickies are any adhesive-type substance found on waste paper, and they can be a big contaminant in any recycled paper-making process.

Smaller undesirables face more screens as the pulp mass moves toward the flotation cells. These holes, six-one-thousandths of an inch in width, stop plastics and other debris that made it out of the drum pulper as well as capture some larger ink particles. As the pulp moves on toward the flotation cells, only ink remains as the last major undesirable targeted for elimination.

Capturing ink in the cell

The barrage on the ink starts 10 feet before the flotation cell where a section of wide pipe called a static mixer injects air bubbles into the pulp slurry as it moves toward the cell. Full of air and water, the pulp is ready to be dumped into a long flotation cell. Bowater's cell is 10 feet wide by 40 feet long. There, the forward movement is stopped, and the mass of pulp nearly comes to rest. As it sits there, the bubbles of air slowly rise to the surface, capturing particles of ink along the way and dragging them to the surface of the mush.

Ink particles hitch rides with the air bubbles because of chemistry. “Air bubbles are hydrophobic, which means they don’t like water,” explains Tom Woodward, marketing manager of Betz PaperChem (Jacksonville, FL). “Hydrophobic things attract other hydrophobic things. Most ink particles are naturally hydrophobic.” Clay particles coming off the OMG fibers also help to absorb more ink.

Once on the surface of the slurry, the ink and ink-soaked clay are skimmed off the top, and the slurry moves to another stage. At Bowater the slurry is put through five flotation cells where ink is continually removed in this manner. In the last cell, the pH level of the water is changed from alkaline to acidic. “This final pH shock helps loosen even more ink,” says Sam Bittes, assistant project manager of engineering for the Calhoun mill. After flotation cells have thoroughly worked the paper, centrifugal cleaners spin the pulp mass. Denser particles, including larger ink particles, are flung to the outside of the vessel and removed.

Finally, the pulp is cleaned across fabric washers. These are actually fine sheets of 60-mesh fabric, meaning they have 60 holes per square inch. This washing stage is somewhat similar to systems that use strictly washing to deink their pulp. The principle is the same in that water is drained from the pulp and more ink is cleaned off, leaving almost 100 percent pulp.

The deinked pulp at Bowater is then dried and used as feedstock for the production of newsprint at the Calhoun mill. Bowater removes 98-99 percent of the ink or “all visible ink,” according to Bittes. The mill adds virgin fiber to produce 2,250 tons per day of newsprint containing up to 40 percent recycled content: on the average, sheets have 15-20 percent recycled content.

Approximately 800 newspapers use Bowater’s recycled newsprint, including USA Today and the Washington Post.

Like laundry in a blender

Strictly washing systems use essentially the same types of initial screens and cleaners as the flotation system described, but the core of the line is large washing vessels or “giant kitchen blenders,” according to Southeast Paper Manufacturing (Dublin, GA). Southeast Paper’s washing system deinks about 560,000 tons per year of ONP to produce 100 percent recycled-content newsprint.

Southeast’s process starts by mixing ONP with 20,000 gallons of water and special chemicals that help pull the ink off the paper. This recipe is mixed inside continuous pulpers, which are 20 feet in diameter and churn the mass with six-foot rotors. “The process lifts ink from paper just like detergents lift grease and dirt from clothes in a washing machine,” the company explains.

What happens next is actually the opposite of what happens in the flotation process. Many of the chemicals in the pulpers change ink particles, which naturally don’t like water, into hydrophilic particles that do like water. “As a result, these particles drain off with the water and the pulp is left behind,” says Betz PaperChem’s Woodward.

“It’s just like doing a load of laundry over and over again—a series of dilutions and thickenings. You rinse it off and hope it doesn’t get back on the clothes—or the pulp,” Woodward notes. Much of the chemicals used in the process are called antiredeposition agents, just like laundry detergents. In fact, Woodward says when he first entered the field of deinking, much of the background information he perused came from the laundry detergent industry. Once completely cleaned, the pulp is bleached with peroxide; this adds brightness to the recycled paper. Using this process, Southeast produces 460,000 tons per day of recycled content newsprint for a number of customers including the New York Times.

Which is best?
Flotation deinking came to the U.S. about five years ago from European and Asian sources. Japan, Germany, Finland, and Sweden had been using flotation deinking for years because they needed to conserve as much water as possible given their limited resources. Since flotation requires less water than washing, it was the system of choice for those countries. In the U.S., meanwhile, washing systems were traditionally the only way paper was deinked. In the past five years, things have changed dramatically. "Washing is relatively expensive compared to flotation," Bowater's Bittes says. "It (washing) was the way it was done since whenever deinking began years ago until about five years ago. It's the older, conventional way of doing it...(and) it uses huge amounts of water." Bowater saves water by primarily using the flotation process.

According to Betz PaperChem's Woodward, the answer to which process deinks better may be both technologies. "If there is a trend in newsprint deinking," Woodward says, "it's a combination approach of washing and flotation deinking, although flotation is often referred to as the workhorse of the two."

Justification for a combination of the two systems makes sense based on newsprint or office paper deinking because mills want to lift as much ink as possible in the quest for brighter recycled sheets. Ink particles come in a wide range of sizes from one to 350 microns or more in diameters. Each system has its limitations in catching different sizes; but working in tandem, the process can remove more ink.

"Washing works best for the smallest sizes in the one-to-20-micron range, while flotation is most efficient in the 20-to-150-micron range," Woodward says. Although the smallest dot of ink visible to the human eye falls around the 60 micron diameter, particles below that can still dull brightness by absorbing rather than reflecting light. Such dullness can be picked up by the human eye. At this point, the choice of which system to use—or which system to use the most of in combination—depends on what a mill wants to produce and what a mill is using as feedstock.

New technologies, tougher inks
With more new types of waste paper being collected for recycling, a need for alternate methods of deinking has arisen in the paper industry. Steam explosion deinking, for example, is slowly gaining speed and acceptance in the paper industry as a viable alternative to flotation or washing. Developed by Stake Technologies Ltd. (Stake Tech, Norval, Ont.), the process literally explodes waste paper into pieces.

In explosion technology, waste paper is fed into a high pressure chamber. Pressure is then dropped suddenly to atmospheric pressure; and, as a result, the paper is torn asunder. While this technology breaks down the waste paper and ink, the process still requires other, more common methods of deinking to remove all the ink, especially if the end product desired is a higher grade sheet such as newsprint or writing paper.

"Steam explosion replaces the hydropulper and the disperser, and in most cases eliminates the need for flotation cells. It's still in the pilot program phase, though," says Brecc Avellar, technical director for DeNovo, StakeTech's development company.

Other new deinking technologies and challenges come with the rise in office paper recycling. Office paper deinking requires a little more work because much of the material has been printed with laser ink. Five years ago, laser inks made up about 30 percent of all collected office paper. Today 80 percent of the ink on office paper is laser. Just about any high-speed copier or printing machine applies laser inks.

The growing prevalence of laser ink, coupled with the increase in office paper recycling programs, raises the stakes because flotation and washing systems have difficulties removing all the laser ink from the paper.

While together, flotation and washing successfully remove ink particles from one to 150 microns. In size some laser particles are bigger than that. This often requires a way to break down further the size of the particles such as with a dispersion unit. Dispersion units heat and soften laser inks and then mechanically tear the paper apart.

Dispersion breaks down the ink and the paper to more manageable sizes, but the actual units can cost extra. In fact, since paper cannot go directly into a dispersion unit, a series of screens and a flotation cell must come before and after the dispersion unit. “To do office waste paper successfully, you have to have a whole second deinking plant,” Woodward says.

Another alternative technology to handle laser inks actually makes the ink particles bigger before removing them. The process that uses centrifugal force involves chemically altering the ink particles to make them denser and larger—in the 350-micron and higher range. Once at that size, particles can be thrown to the outside by a centrifugal cleaner. This process separates the ink and the pulp just as other deinking processes do.

Not all inks lend themselves to any of these processes. The goal of removing ink from paper is still out of reach for some printed items such as ultraviolet (UV) cured inks. These inks decorate luxury packaging, such as perfume boxes, with highly colorful designs. UV-cured inks were designed in response to environmental objections to the amount of solvents that were originally being used to make such packaging.

The solution to these environmental outcries was ink that is designed to polymerize in the presence of UV light. Although non-deinkable, packaging blazoned with these inks can be recycled into items, such as boxboard or corrugated medium, which don’t require ink removal prior to recycling. Perhaps, however, if UV-cured inks become more widespread, deinking technology for those inks will follow.

Current and Planned Newsprint Deinking Facilities in North America

Company	Location	Capacity (in Tons) Metric	Short
Existing Recycled Newsprint Mills, 1991			
Atlantic Newsprint Co.	Whitby, Ontario	85	94
Augusta Newsprint Co.	Augusta, Georgia	352	388
Bowater, Inc.	Calhoun, Tennessee	733	808
CPFP	Thunder Bay, Ontario	465	513
Fletcher Challenge Canada	Crofton, British Columbia	150	165
FSC Paper Corp.	Alsip, Illinois	132	146
Garden State Paper Co.	Garfield, New Jersey	209	230
Inland Empire Paper Co.	Millwood, Washington	72	79
Manistique Papers, Inc.	Manistique, Michigan	53	58
MacMillan Bloedel Ltd.	Port Alberni, British Columbia	150	165
	Powell River, British Columbia		
North Pacific Paper Co.	Longview, Washington	700	772
Quebec & Ontario Paper	Thorold, Ontario	313	345
Smurfit Newsprint	Pomana, California	129	142
	Newberg, Oregon	361	398
	Oregon City, Oregon	219	241
Southeast Paper Mfg. Co.	Dublin, Georgia	406	448
Spruce Falls Power & Paper	Kapuskasing, Ontario	314	346
Stone Containers Corp.	Snowflake, Arizona	279	308
Total		5,122	5,646
Recycled Newsprint Mill Projects Under Way, 1992-1994			
Canadian Pacific Forest	Gatineau, Quebec	440	485
Daishowa Forest Ltd.	Quebec City, Quebec	300	331
Kimberly- Clark Corp.	Coosa Pines, Alabama	310	342
Kruger, Inc.	Bromptonville, Quebec	54	60
	Trois Rivieres, Quebec		
Boise Cascade Corp.	Steilacoom, Washington	178	196
Champion International	Houston, Texas	450	496
Donahue, Inc.	Clermont, Quebec	322	355
James MacLaren Industries	Masson, Quebec	191	211
Stone-Consolidated, Inc.	Shawinigan, Quebec	200	300
Evergreen Pulp & Paper Co.	Redrock, Arizona	300	331
Recycled Newsprint Mill Projects Approved But Indefinitely Delayed, 1992-1994			
Alabama River Newsprint (Abitibi-Price/Parsons & Whittemore)	Claiborne, Alabama	220	243
Bowater	E. Millinocket, Maine	—	100

Making Paper

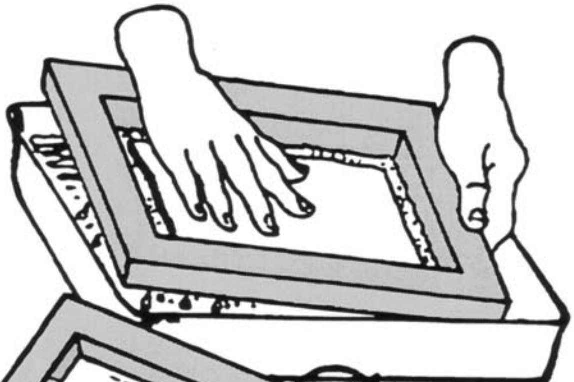
1. Tear sheets of used paper (one different type of paper for each group of students) into small strips about one-inch square. Loosely pack into blender until 1/3 to 1/2 full. Add warm water until blender is 2/3 full.

2. Blend., with lid on, until the paper looks like oatmeal (5 to 10 seconds).

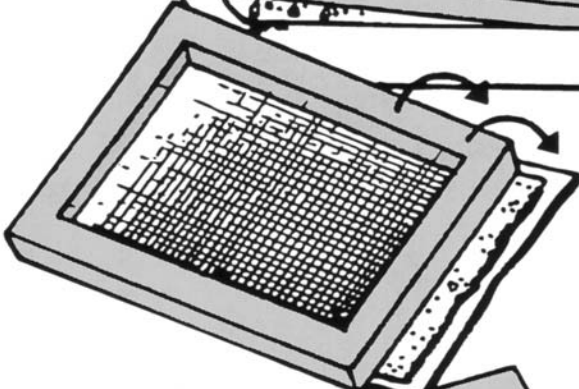
3. Empty the blender into a pan and add about 1/2 inch (1.3 cm) of water for every blender of pulp, adding more or less depending upon the thickness of paper desired.

4. Scoop the pulp mixture evenly onto the screen with a cup (hold the frame over half the pan). Let the pulp drain.

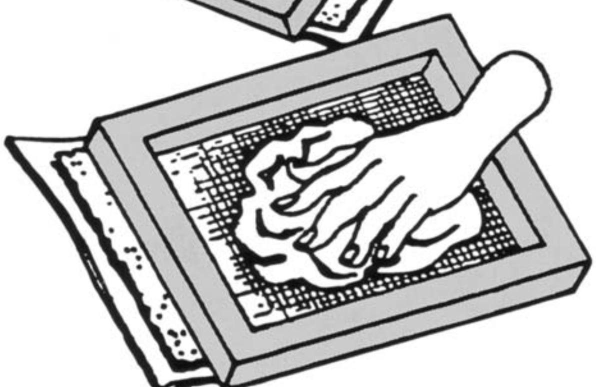
Option: you may dip the screen *under* the pulp and pull it up so that the pulp spreads out evenly on the screen. Don't forget to let the excess water drain into the pan.



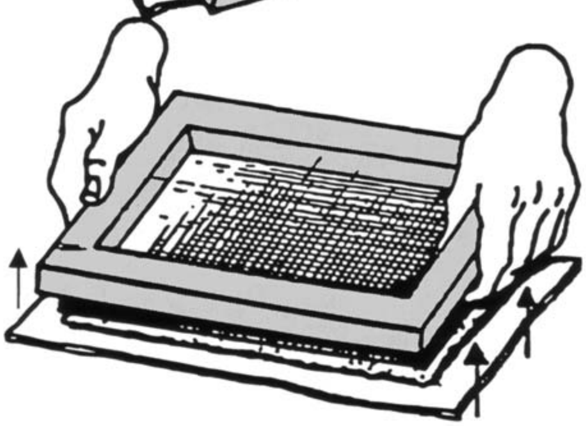
5. Lay a piece of blotter paper over the wet pulp paper formed on the screen.



6. Flip the screen over so that the pulp paper is between the blotter and the screen with the screen on top.



7. Soak up extra water with a sponge. This water can be squeezed out and collected along with the water in the pan.



8. Lift off the screen and place the new paper in a safe place to dry. Drying takes one or two days. Exchange blotter and dry paper towels every few hours if you want the paper to dry more quickly, or you may iron the paper to speed up the process. If you choose to iron your paper, place a sheet of paper between the new paper and the iron.

Plastics, Everywhere

OBJECTIVE:

Students will be able to:

1. Explain how recycling and using biodegradable products conserve resources and protect the environment.

Grades:
6-8

Subject:
Science

Time Needed:
45 minutes

Materials:
plastics use chart

BACKGROUND:

Plastics are wonderful materials. Some are soft and pliable; others are hard and durable. Some plastics are nearly unbreakable and can last as long as a human life time. However plastics have some serious drawbacks. They add to garbage and add to a growing problem of trash disposal. Many plastics are recyclable. Most plastics are nonbiodegradable, which means they do not break down through natural processes. Plastics are made from petroleum that is a nonrenewable resource. We use plastic goods in our daily lives so much that we are not aware that often we are responsible for polluting the environment. We can limit the usage of nonrecyclable plastic materials and can use substitutes for the protection of the environment. Plastics make up 10.5% of the municipal solid waste stream.

VOCABULARY:

biodegradable, nonrenewable resources, recyclable plastics

PROCEDURE:

1. Give each student a copy of the "Plastics, Everywhere" chart. Ask them to make a list of things they often use that are made of plastic.
2. Then have them list objects or materials to replace plastic that are either recyclable or biodegradable.
3. Have the students indicate whether or not they are willing to use the substitutes for the things they listed made of plastics.

EVALUATION:

1. Was it easy to think of substitutes for the nonrecyclable plastics?
2. Were most of your substitutes biodegradable or recyclable?
3. Which way is better: to find biodegradable items or to find recyclable items?

EXTENSION:

1. Research the recycling program in your area. Are plastics recycled?
2. Compare energy costs of recycling versus biodegradation.

ORIGINAL DEVELOPMENT RESOURCES:

www.epa.gov

Plastics, Everywhere

Plastic Items	Substitute	Would I Use It?
Example: Shopping Bags	Cotton/Fabric Bag	Yes

Precycling

OBJECTIVES:
Students will be able to:
1. Understand and publiciae precycling concepts.
2. Describe the properties of plastic that make it recyclable.
2. Determine the monetary savings gained when plastic is recycled.

Grades:
6-8

Subjects:
Science, Math

Time Needed:
One to two class periods

Materials:
assortment of plastic containers
pencils
markers
poster boards
papers

BACKGROUND:
In 1989 the city government of Berkeley, California, initiated a campaign to encourage consumers to buy food packaged in biodegradable or recyclable materials. They called it "precycling." "Precycling" is the term used for something we can all practice just by following this familiar slogan, "Reduce waste before you buy!" Simply by making the correct buying choices, by precycling, we can prevent excessive and nonrecyclable materials from getting into our waste stream. Each American uses about 190 pounds of plastic per year, and about 60 pounds of it is packaging we discard as soon as the package is opened? Americans also go through 2.5 million plastic bottles every hour. This means that roughly 5 million tons—more than half of all plastics we throw away each year—are from packaging. Precycling may be the easiest way to help save the Earth. People can learn to precycle while they shop.

VOCABULARY:
recycling, pollution, waste, precycle, plastic

ADVANCE PREPARATION:
1. Explain to the students what precycling means.
2. Have paper, pencils, poster boards, and an assortment of plastic containers available for the students to use. You may also want to bring in markers so the students can be more creative when drawing on the poster boards.
3. Research various types of plastics, especially the cost of materials, energy to produce, and waste management.

PROCEDURE:
Setting the Stage
1. Have various plastic containers in view for all students to observe.
2. Discuss with the students the similarities and differences of the various plastic containers, and hypothesize how much plastic we throw away each day and year.
3. Explain to the students that they will be starting a plastic recycling program.
4. Discuss with the students the various recycling code numbers on plastics.

Activity
1. Begin the activity by displaying an assortment of plastic containers and discussing with the students the "real" costs of producing plastics and how much plastic is sold.
2. Locate and contact the nearest plastic collection center for the current market price.
3. Determine how much plastic the students will have to collect to make a purchase for the school.

4. Find out how long it will take to collect the money needed. Plan the amount of plastic they will need to collect each week.
5. Determine the kind of incentives that will be offered to encourage student participation.
6. Share this example of a successful class venture:

   School—Phillips Preparatory
   Enrollment—800 students
   Goal—$800 for a computer
   Weekly collection at school (amount)
   Average price of plastic
   Value of weekly collection—between $23 and $24
   Time needed—33 to 35 weeks or approximately 1 school year
7. Have the students make posters and announcements explaining the plastic recycling program. Also have them make posters about what precycling is and the fact that everyone should be more aware of buying precycled containers in the grocery stores.

Follow-Up

1. Have students list examples of simple "precycling" tips. For example:
   - Buy eggs in cardboard, not Styrofoam, cartons.
   - Most cereal boxes are made of recycled cardboard. It's easy to tell—the boxes are gray on the inside. The packaging for many varieties of cookies, crackers, or dry goods often is recycled. So it helps to buy cereals in recycled boxes.
   - Look for the "recycled" logo on food packages.
   - Buy fresh fruit and vegetables loose rather than in plastic bags.
   - Avoid plastic containers, especially "squeezable" ones, which are made up of different types of plastic in several layers and are non-biodegradable and non-recyclable.

EXTENSIONS:

1. Try this exercise with containers made of other materials like aluminum.
2. Interview people who are involved in waste management (elected officials, sanitary landfill operators, recycling center personnel) and write an article about your findings.
3. Take photographs of your collection process and write an article for publication in a local or regional newspaper.
4. Find out what your community pays for plastic litter. How much money would the taxpayers save if plastic were not discarded as litter?
5. List some ways the recycling of plastic benefits you as a citizen.

ORIGINAL DEVELOPMENT RESOURCES:

The Earth Works Group. (1989). *50 simple things you can do to save the earth*. Berkeley, CA: Earthworks Press.

Holmes, N. J. (1985). *Gateways to science* (Grade 5). New York, NY: McGraw-Hill.

ADDITIONAL RESOURCES:

Javna, J. Javna, S. &Javna, J. (2008) *50 Simple Things You Can do to Save the Earth*.

Talking Trash: Biodegradable Landfills?

OBJECTIVES:

Students will be able to:

1. Identify the degradable rate of certain products.
2. Identify specific ways to limit amounts of trash created by people.

BACKGROUND:

Each American produces in excess of 4 1/2 lbs of garbage a day. Americans produce in excess of 220 million tons of garbage (solid waste) a year. Fifty-five percent of the waste in the United States is buried in municipal landfills. The number of municipal landfills has declined by over 50 percent since 1979, which has caused a definite solid waste crisis. According to the Environmental Protection Agency, the U.S. has 3,091 active landfils and more than 10,000old municipal landfills.

It is estimated that more than half the nation's cities will run out of landfill capacity in less than five years. According to 2010 data, the following are the percentages of wastes found in a typical landfill:

paper products	28.5%
glass	4.6%
plastic products	12.4%
yard waste	13.4%
food items	13.9%
rubber, leather, & textiles	8.4%
metal	9%
wood	6.4%
other	3.4%

Grades:
6-8

Subjects:
Science, Math

Time Needed:
Two to three class periods over a period of five to six months

Materials:
disposable paper and plastic materials from various fast-food restaurants
0.75 mil plastic bag
shovels

Landfills contain pollutants like pesticides, solvents, and heavy metals that are harmful to people and wildlife. Every three months, the United States throws away enough iron or steel to supply the auto makers of the United States and Japan. Enough aluminum is thrown away to rebuild the entire U.S. air fleet every three months. Not only does household waste end up in landfills; but also industrial and municipal wastes are dumped in landfills, which could contain sewage, hospital, and military wastes. If leachate from landfills is not controlled, it can contaminate groundwater. Another problem that landfills may create involves the production of dangerous levels of methane gas. As layers of garbage compact and decompose, methane gas is produced and is released into the air causing air pollution.

"Garbologists" are discovering that things they thought would decompose, don't. They have found 50-year-old carrots, steaks, newspapers, and other so-called "biodegradable" materials still intact.
Consider these facts:

- The U.S. throws away enough paper products in *one year* to build a 12-foot wall from Los Angeles to New York City.
- Every *two weeks* the U. S. throws away enough glass and bottles that, if stacked, would reach 1,350 feet—nearly as tall as the Empire State Building.
- Every *20 minutes* there are enough cars dumped in landfills that, if stacked on top of each other, would

reach the top of the Empire State Building.
- It takes 2-3 years for a plastic garbage bag to decompose.
- It takes 1-5 years for a winter sock to decompose.
- It takes less than 1 year for a newspaper to decompose (usually).
- It takes 350 years for a diaper to decompose.
- It takes 50 years for a leather purse to decompose.
- It takes 1 million years for glass to decompose.

Many landfills leak, causing contamination of the groundwater supply. New landfills created since October 1, 1993, control leachate—the leaking of landfills—by using a plastic lining and layers of sand, clay, and gravel at the bottom. However, some older landfills that were not lined by these methods continue to contaminate water supplies.

There are many things that the public can do to reduce the amount of garbage that ends up in landfills:

Reduce: Create less waste by thinking before you buy items. Don't buy disposable things such as spray cans, plastic pens, Styrofoam items, juice boxes, and items using excess packaging. Use "customer power" and avoid wasteful packaging like disposables and excess packaging. (See also "Precycling" activity.)
Reuse: Buy items that can be reused rather than thrown away such as plastic containers instead of Styrofoam throwaways, rags instead of paper towels, and rechargeable batteries. Batteries are a major problem for landfills! Every year foam packaging thrown in landfills could cover Washington, DC, in one foot of trash. Repair things instead of replacing things. Borrow or rent tools. Donate clothes instead of just throwing them away. Compost as much as you can. Remember, toss means loss.
Recycle: Recycle as much as possible. Besides the typical newspapers, plastics, and glass, there are many other things that can be recycled that you might not have thought of. Many scrap metal companies will take old wire, pipes, and metal materials. Purchase paper and other products that contain recycled materials content.

VOCABULARY:
biodegradable, landfill, leachate, groundwater, garbologist, decompose, methane gas

PROCEDURE:
1. Have the students collect disposable paper and plastic materials from various fast-food restaurants.
2. Separate the materials collected into two groups.
3. Place one group of materials into a 0.75t mil thick garbage bag.
4. Bury both groups of materials (bagged and non-bagged) 1-2 feet into the ground.
5. Have the students make hypotheses about the two groups as to their biodegradability.
6. After about 5-6 months, dig up material. Wear gloves.

Follow-Up:
1. After about 5-6 months, dig up material. Wear gloves.
2. Analyze the material for an approximate percentage of decomposition.
3. Have the students record their conclusions.
4. Discuss the fact that water and air are needed for decomposition and that, if those cannot reach the material in a landfill, it will not decompose very fast.

EXTENSIONS:
1. Take a field trip to a local landfill.
2. Have the students research landfills and trash/garbage. Then write a script for a video. Have the students produce a video that will teach others about the importance of trash reduction. Place the video in the school library or have the students present the video to classes.

3. Make an appointment to meet the Public Service Director or Community Affairs Director of a local TV station or radio station. Then create a Public Service Announcement (PSA) about the importance of reducing trash and the ways homeowners can reduce, reuse, and recycle.

ORIGINAL DEVELOPMENT RESOURCES:

www.epa.gov (gives list of Alabama permitted landfills)

Notes

Tin Can Incinerator

OBJECTIVE:
Students will be able to:
1. Calculate the reduction in weight and volume of solid waste from burning.

BACKGROUND:
This activity illustrates the volume and weight reduction possible through burning waste. It also illustrates that burning produces air emissions, but it does not simulate the operation of a state-of-the-art incinerator. While open-air burning allows pollutants to escape into the atmosphere, today's incinerators capture about 99 percent of those emissions. Therefore, weight and volume reductions will be more dramatic in this experiment than in an incinerator.

Caution: Do as a Teacher Demonstration
1. Do not burn any types of plastics. It is impossible to tell what types of resins and/or additives are used in the hundreds of different plastic packaging types. Many plastics, such as PVC, polypropylene, or polystyrene, produce toxins when burned.
2. Perform this experiment outside if your school does not have laboratory facilities for burning. Also, it is necessary to have a fire extinguisher or fire blanket handy.

VOCABULARY:
volume, ash, incinerate, toxins, precipitator

ADVANCE PREPARATION:
1. Using a punch-type can opener, punch several ventilation holes about one inch from the bottom of the one-gallon metal can.
2. Gather ignitable materials for the activity.

Grades:
6-8

Subjects:
Science, Math

Time Needed:
One to two class periods

Materials:
one-gallon metal can
a piece of metal screen large enough to cover the top of the can
five pieces of cardboard six inches square
masking tape or use a pre-made box (like a shoe box)
enough solid waste to fill a box 6" x 6" x 6" (15 cm x 15 cm x 15 cm)
materials that are easy to ignite such as paper, popsicle sticks, kindling
matches
ruler and balance
marker
safety goggles

PROCEDURE:
Setting the Stage
1. Distribute student worksheets and explain that in this lesson waste items will be burned to observe the effects on incineration. Tape cardboard pieces together to form a box with four sides and a bottom or use a pre-made box such as a shoe box. Fill the box with the waste and have the students calculate the volume.

   Volume of waste = length x width x height(depth). This can be expressed in inches or cubic cm.

Activity
1. Transfer the waste from the cardboard box to the gallon can. DO NOT BURN THE CARDBOARD BOX. Light the materials and immediately cover the top of the can with the screen. Observe what comes out of the can while the materials are burning. Have the students record their observations in the appropriate area on the worksheet for future discussion.
2. When burning is complete and the ashes have cooled, return the ashes to the cardboard box. Spread them evenly on the bottom of the box and measure the height (depth) of the ash layer.

Using the same formula above, calculate the volume of the ash. Now calculate the difference in the volume occupied by the waste before and after burning.
3. Weigh box of waste before burning and afterwards with ashes. Record results on student worksheet.

EVALUATION:

1. Give correct computation of the formulas.
2. Draw correct conclusions as indicated at bottom or worksheet.

EXTENSIONS:

1. Try incinerating an equal volume of food scraps (orange or banana peels, egg shells, apple cores, etc). You may want to dry these out so they will burn more easily. Which is easier to burn, the food scraps or the paper and wood products from the original experiment? Which would take longer to incinerate? Are the final by-products from both experiments the same?
2. The classroom experiment allowed some ash, heat, and other by-products of burning to escape into the atmosphere. However, incinerators are required by law to have precipitators to remove ash and toxins from air emissions. Research different methods of pollution control in incinerators.
3. What happens to the ash that is collected after incineration is complete?

Student Worksheet

Name ___________________ Date ________________ Period _________________

Chart #1: Volume

A Volume of waste in can before burning $V=W^2\pi$	B Volume of ash in can after burning $V=W^2\pi$	C Difference in Volumes (A-B)	D Divide C by A	E Multiply D x 100 (this is the percent decrease in volume)

Chart #2: Weight

F Weight of can and paper (gms)	G Weight of can and ashes (gms)	H Difference in weights (F-G) (gms)	I Divide H by F	J Multiply I x 1-0-(This is the percent decrease in weight) %

Observations while burning:

____
____
____
____
____
____

Conclusions

From your observations and experiment, you should be able to make some conclusions about incineration and reduction of waste. What are your conclusions? Compare an open burning scenario, like the one you just completed, to that of a controlled incinerator where air emissions are monitored and most ash particles are removed from the air. Compare and contrast the impact of open burning versus incineration. Use a separate piece of paper.

Notes

Demonstrating Hazardous Wastes

OBJECTIVES:

Students will be able to:

1. Define hazardous substances.
2. Describe four categories of hazardous waste, the effects of each on the environment, and the methods for disposal.

Grades:
6-8

Subjects:
Science, Chemistry

Time Needed:
Three class periods

Materials:
apron
protective eyeglasses
WD-40 spray can
large laboratory beaker (1000 mL)
long match or wood splint
small cube of elemental sodium
acetic acid
4 living plants (annuals are the best)
hydrochloric acid
metal filings
sodium bicarbonate
metal gauze
rubber gloves
salt
gallon container

BACKGROUND:

According to the Resource Conservation and Recovery Act (RCRA) of 1976, hazardous waste is defined as any solid, liquid, or contained gaseous waste that may cause, or significantly contribute to, serious illness, injury, or death, or that could damage or pollute land, air, or water when improperly managed. Hazardous wastes come from many sources and are found in many forms. They are categorized as toxic, reactive, ignitable, or corrosive. Examples of such wastes are waste pesticides generated by agriculture and the waste discharged from industrial operations such as manufacturing batteries, smelting, and refining metal.

The disposal of hazardous wastes and substances that might pollute air, water, or land are regulated by the EPA (Environmental Protection Agency). Household hazardous wastes are not regulated. The improper management of hazardous waste can be disastrous to the environment and to public health. Damage to the environment may take many forms: groundwater and water supply contamination, wildlife habitat destruction, soil contamination, fish kills, livestock loss, air pollution, fire, explosion, and crop damage. Damage to health may be directly related to these environmental effects, but it is often more subtle, even undetectable in its early stages. The price we pay for having these materials is higher than we realize. The major purpose of this activity is to demonstrate the effects of hazardous wastes on the environment.

VOCABULARY:

hazardous waste, toxic, ignitable, reactive, hazardous substance, corrosive

ADVANCE PREPARATION:

1. Explain to the students that they will be investigating these four major categories of hazardous substances (toxic, reactive, ignitable, and corrosive). Their studies will include the following items:
   - The definition
   - A demonstration of its effect
   - Identification of products containing the hazardous substance
2. Have all the materials on hand to do the experiments. Review with the students the proper lab techniques. Use extreme care when doing these activities.

PROCEDURE:

Setting the Stage

1. Begin this activity by asking the students to write down what they think "hazardous waste" means.
2. Ask the students to list the types of hazardous substances. Post the correct responses on the chalkboard (toxic, ignitable, reactive, corrosive).

Activity

Experiment 1

1. Ask the students to define "ignitable." Explain the characteristics of ignitability and demonstrate it as follows (TEACHER DEMONSTRATION ONLY):
   - Spray WD-40 into a beaker.
   - Quickly ignite the carrier of the substance (propane or butane) using a long match or a lit wood splint. Warning! Flash fire might occur. The flame will burn out quickly.

Experiment 2

1. Ask the students to define "reactive." Explain to them the characteristics of "reactivity" and demonstrate as follows:
   - Pour water into a large beaker (1000 mL) until it is half full.
   - Drop a pea-sized cube of elemental sodium into the beaker. Immediately cover it with wire gauze to keep splashing to a minimum. ***Caution:*** THIS ACTIVITY IS POTENTIALLY DANGEROUS. KEEP STUDENTS AT A DISTANCE. USE RUBBER GLOVES, GOGGLES OR A FACE SHIELD, AND AN APRON.
   - Add more small bits of sodium—MINUTE AMOUNTS—if you wish to demonstrate a more violent reaction.
   - Determine the pH of the resulting solution (it may be 12 or 13). If the pH of a basic substance is over 12.5, it is characterized as a corrosive liquid.
   - Add enough acetic acid to the beaker to neutralize the sodium hydroxide.
2. Ask the students the following questions:
   - Did an explosion occur? If so, why?
   - Are bubbles being emitted? If so, why is this occurring? (Hydrogen is given off.)
   - Has the temperature of the beaker changed? (This activity generates heat.)
   - What products contain sodium in compound form? (table salt, sodium bicarbonate, sodium hydroxide)

Experiment 3

1. Ask the students to define "corrosive." Explain the characteristics of corrosiveness and demonstrate as follows:
   - Pour a small amount of hydrochloric acid into a beaker.
   - Carefully pour some metal filings into the beaker. Ask the students why the filings are dissolving.
2. What would neutralize the acid?
3. Add sodium bicarbonate to neutralize the solution. Ask the students what product contains hydrochloric acid. What product contains sodium bicarbonate?

Experiment 4

1. Ask the students to define "toxic." Explain the characteristics of toxicity and demonstrate as follows:
   - Prepare a solution of one teaspoon of salt and one gallon of tap water (Solution A–about 2000 ppm).
   - Remove one cup of Solution A, and to that cup add nine cups of tap water (Solution B–about 200 ppm).
   - Remove one cup of Solution B, and to that cup add nine cups of tap water (Solution C–about 20 ppm).
2 For a control, Solution D will be only tap water.
3. Use equal amounts of Solution A, B, C, and D to water four living plants. (Small annuals work well.) Water for two weeks.

Follow-Up

1. Have the students identify products in their homes that are labeled “ignitable,” “explosive,” “corrosive,” and “toxic” and ask them to bring lists of these products to class.
2. Discuss the lists found in their homes.
3. Keep a record of each plant’s growth and the solution used to water it. Evaluate all demonstrations and results. Ask the students to describe the effects of each type of hazardous waste.

EXTENSIONS:

1. Have the students list what they can do personally to reduce the amounts and kinds of hazardous waste in the home.
2. Have students think of ways to demonstrate (safely) some of the hazardous effects of common household products so that their parents and friends will become aware of them.

ORIGINAL DEVELOPMENT RESOURCES:

Environmental Protection Agency. (1986). *Understanding the small quantity generator hazardous waste rules: A handbook for small business.* Washington DC. www.epa.gov

Notes