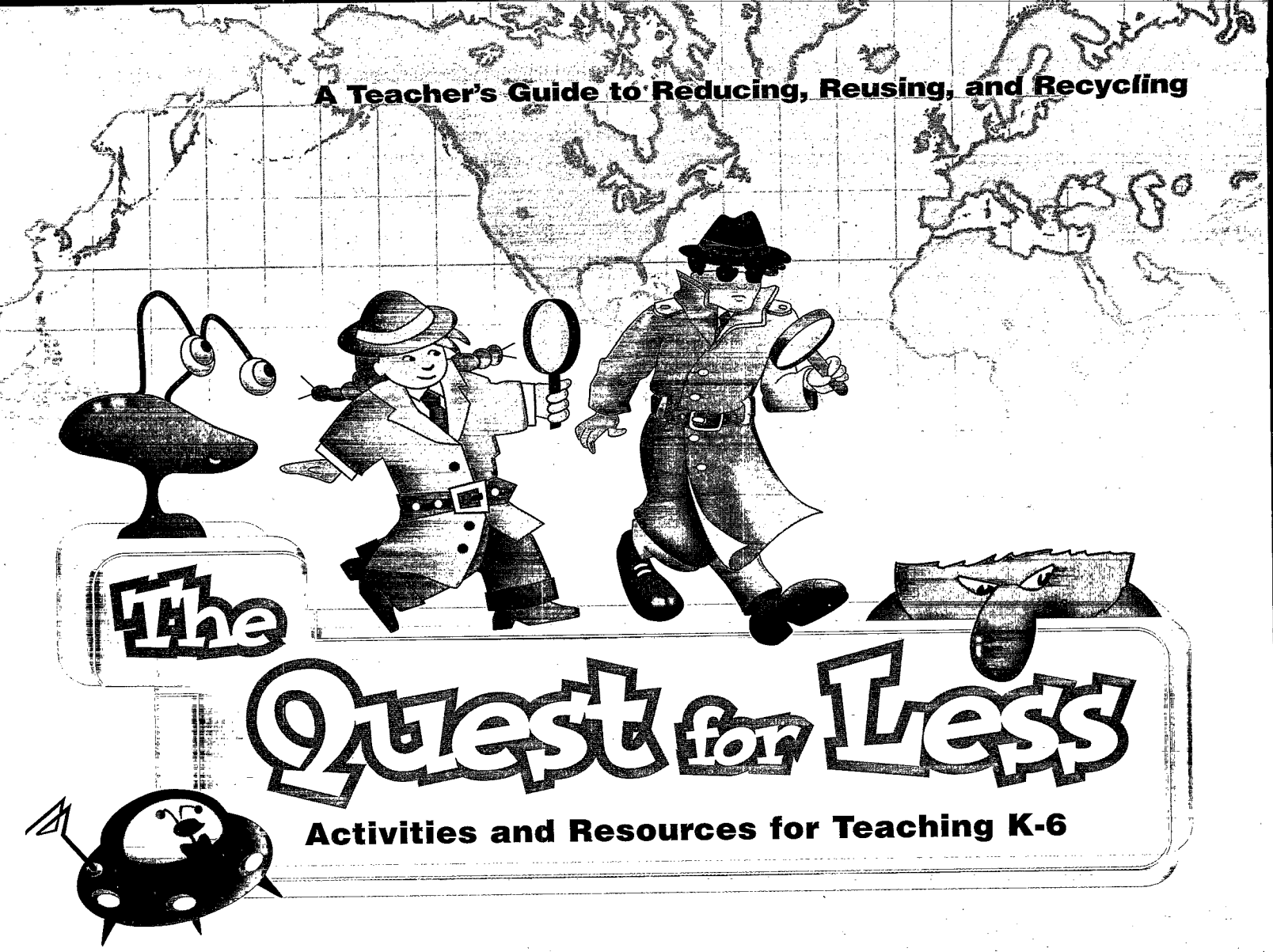
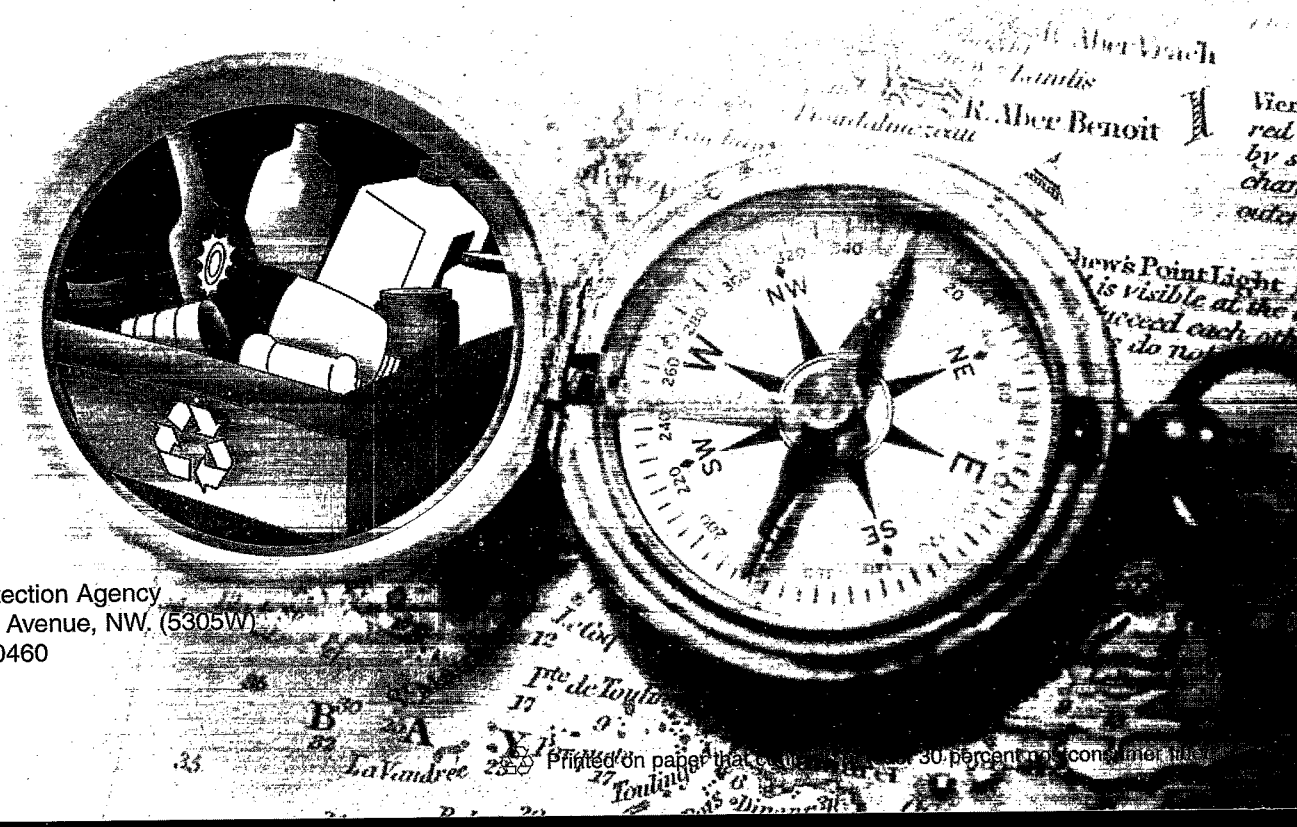
A Teacher's Guide to Reducing, Reusing, and Recycling



The Quest for Less

Activities and Resources for Teaching K-6



EPA

United States
Environmental Protection Agency
1200 Pennsylvania Avenue, NW, (5305W)
Washington, DC 20460

EPA530-R-00-008
November 2000
www.epa.gov/osw

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This page provides a cut-out "spine" for your binder. You can also cut out the tabs provided on this page and attach them with tape to each chapter separator for easy reference throughout the document.

Natural Resources

Composting

Products

Source Reduction

Waste

Landfilling and Combustion

Recycling

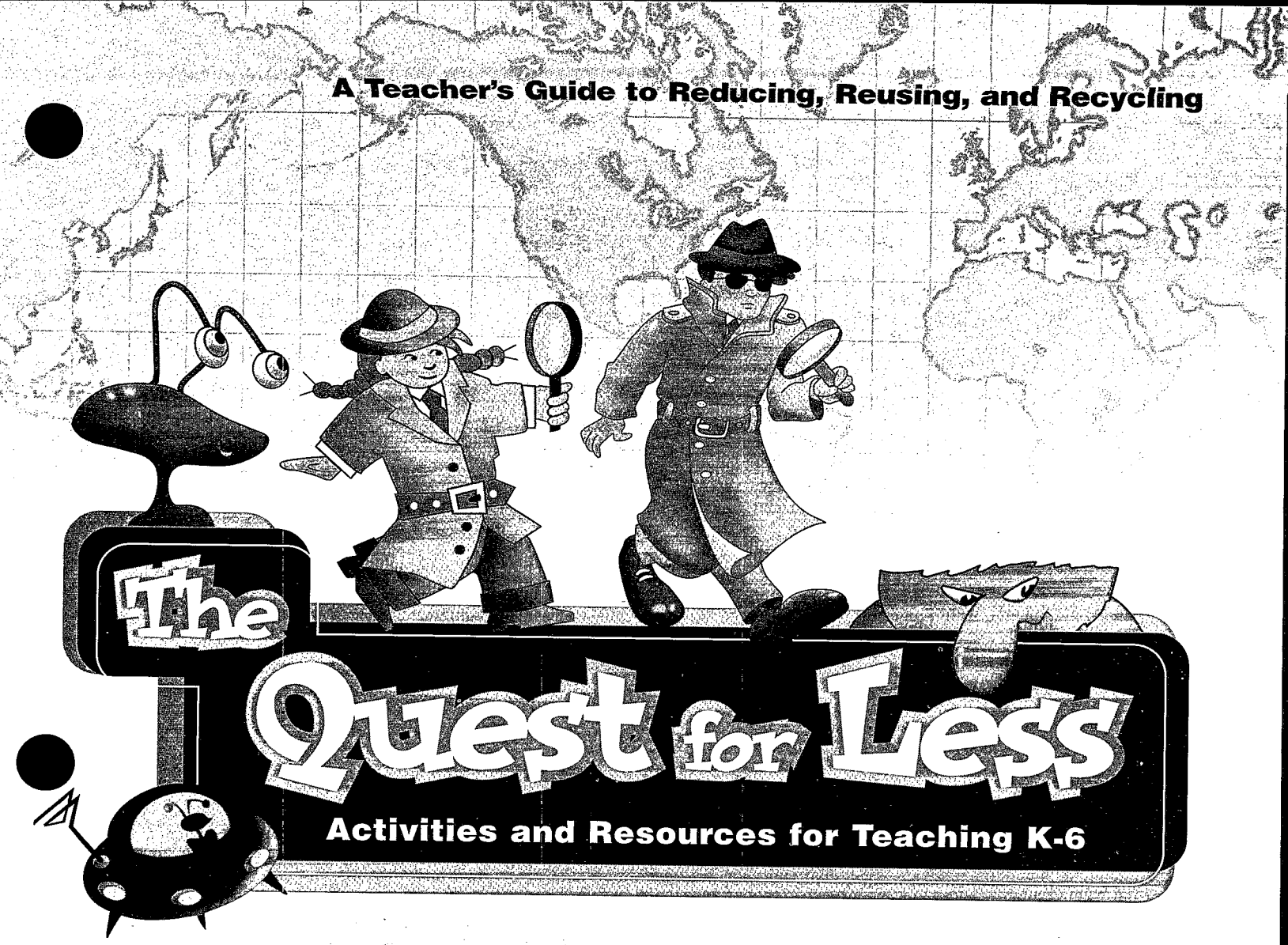
Waste in Review

Glossary

The Quest for Less

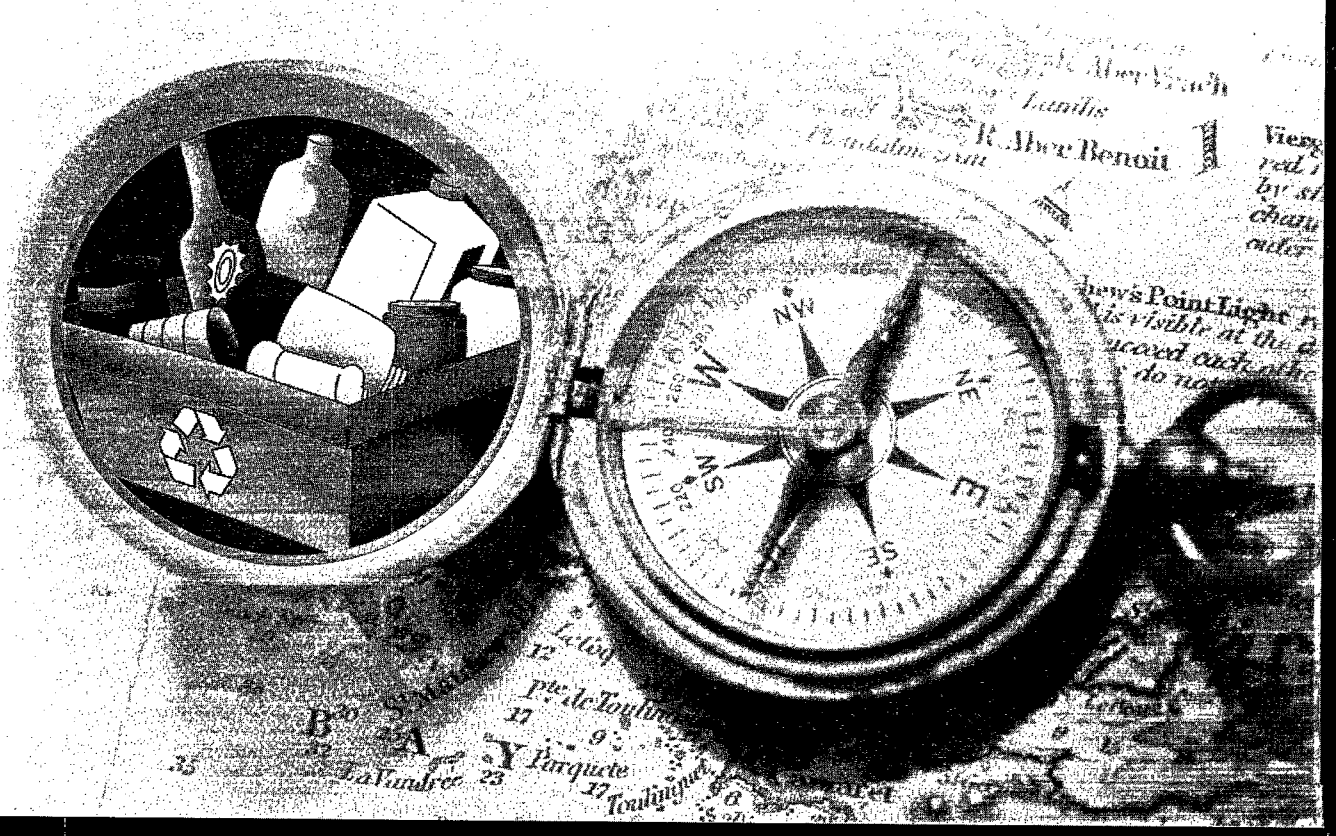
EPA

A Teacher's Guide to Reducing, Reusing, and Recycling



The Quest for Less

Activities and Resources for Teaching K-6



Special Thanks

The U.S. Environmental Protection Agency's Office of Solid Waste would like to thank all of the teachers and students who contributed their thoughts and ideas to the development of this resource in 1998 and 1999. Focus groups with teachers and students were held in Kansas City, Kansas; Alexandria, Virginia; Atlanta, Georgia; and Chattanooga, Tennessee.

We would like to extend special thanks to a group of educators who served as a review panel for this resource during its development. Teachers in kindergarten through sixth grade, as well as curriculum specialists, participated in an Internet-based evaluation group. From May 1999 through July 2000, they electronically reviewed materials under development. The following individuals participated on this panel:

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Disclaimer: Publication of this document by the U.S. Environmental Protection Agency does not constitute an endorsement of any specific consumer product.

WELCOME to EPA's Solid Waste Resource for Teachers and Kids in Grades K-6!

About This Resource

The U.S. Environmental Protection Agency (EPA) designed this solid waste resource as a flexible tool for teachers of kindergarten through sixth grade. Its multidisciplinary focus includes math, science, art, social studies, language arts, and health. Lessons encourage students to utilize skills ranging from reading and writing to problem-solving and analytical thinking.

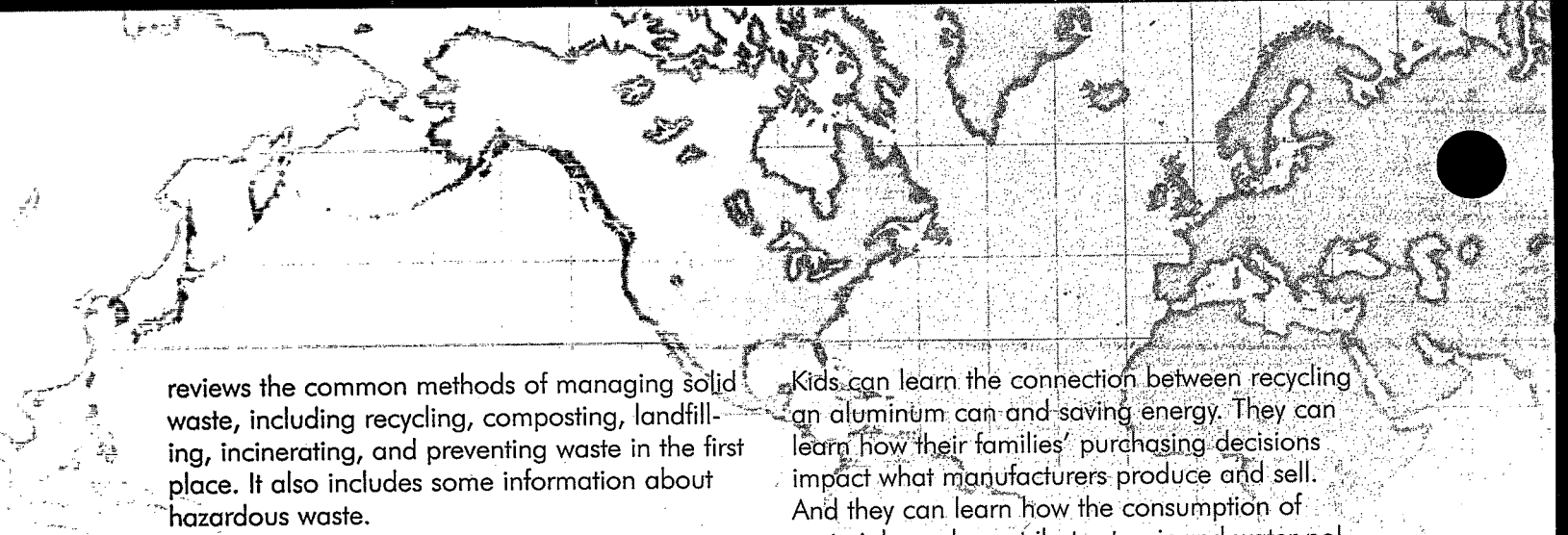
Teachers can use this resource as one of many tools in the development of their lesson plans, incorporating a range of its suggested activities and subjects into different educational units throughout the school year. Activities and concepts can be incorporated into existing curricula, or teachers can create special week-long units on the environment and solid waste or use the activities to commemorate Earth Day.

The Quest for Less **provides hands-on lessons and activities, enrichment ideas, journal writing assignments, and other educational tools related to preventing and reducing trash. Each chapter includes one or more fact sheets providing background information on each topic. In addition, each chapter includes an index showing the grade ranges, subject areas, and skills used for each activity to help teachers select the appropriate activities.**

Each activity provides the suggested duration, materials needed, and other helpful information for teachers. A glossary of terms and a glossary of skills can be found at the end of the resource. Covered sequentially, this resource introduces the idea of natural resources as a source for many products that become solid waste; explains the life cycle of products and the quantity and type of waste they produce; and

Goals of This Resource

- To stimulate young people to think critically about their own actions and the results of their actions and to assess their own resource conservation and waste prevention values.
- To help young people understand the connections among the use of natural resources, use of products, waste disposal, and causes and effects of environmental impacts.
- To help students understand the hierarchy of preferred waste management options and students' role in the different options (e.g., reduce, reuse, and recycle before disposal).
- To introduce and explain behaviors that conserve resources, reduce environmental impacts, and enhance sustainability such as source reduction, recycling, buying recycled, buying with less packaging, and composting.
- To help protect children's health through increased awareness and behavioral changes related to the safe use, storage, and disposal of household products containing hazardous constituents, such as cleaners, pesticides, and batteries.
- To make solid waste education interesting, fun, and an integral part of environmental education.
- To help students understand the concept of personal responsibility toward the environment and to inspire them to make a positive environmental impact in their home, school, and community.



reviews the common methods of managing solid waste, including recycling, composting, landfilling, incinerating, and preventing waste in the first place. It also includes some information about hazardous waste.

Why Should Kids Learn About Garbage?

Despite the fact that individuals and communities are recycling more than ever, each person in the United States continues to generate about 4.5 pounds (EPA, 1998) of municipal solid waste per day! This statistic emphasizes the continuing need to teach the next generation about reducing waste and to energize schools and communities to promote environmental awareness.

Because solid waste—or garbage—issues are intimately connected with resource and energy use, global climate change, air pollution, water pollution, and other concerns, lessons and activities in *The Quest for Less* can be incorporated into other environmental or ecological concepts.

What Is EPA's Office of Solid Waste?

The mission of EPA's Office of Solid Waste is to protect human health and the environment by ensuring responsible national management of hazardous and nonhazardous waste. Close interaction with states, industry, environmental groups, tribes, and the public enables EPA to promote safe and effective waste management. Because everyone contributes to the problems of solid waste, everyone shares responsibility for finding and implementing solutions.

In that spirit of cooperation, EPA reaches out to educators with this resource, enabling them to instill fundamental environmental awareness and values in today's youth and tomorrow's leaders.

Kids can learn the connection between recycling an aluminum can and saving energy. They can learn how their families' purchasing decisions impact what manufacturers produce and sell. And they can learn how the consumption of material goods contributes to air and water pollution. Recognizing that educators have a unique opportunity to shape students' environmental attitudes, EPA's Office of Solid Waste created this resource to equip teachers with facts and ideas for use in the classroom.

Sources

In developing this resource, EPA used the North American Association for Environmental Education's (NAAEE's) *Guidelines for Excellence in Environmental Education Materials* as a guiding principle. NAAEE's guidelines address educational standards for fairness and accuracy, depth, skills building, action orientation, instructional soundness, and usability. Information about the organization can be obtained by contacting NAAEE at P.O. Box 400, Troy, Ohio 45373 or calling 937 676-2514.

Facts presented throughout this resource derive from a variety of governmental, educational, and trade association sources. While all have been evaluated by EPA, they have not been independently verified and might become out of date over time or with changes in the solid waste industry or individual/community behaviors. Some facts are specifically attributed to EPA's *Environmental Fact Sheet: Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 1998*, published April 2000 (document # EPA530-F00-024).

This doucment updates and replaces OSW's previous solid waste teacher's guide, *Let's Reduce and Recycle: Curriculum for Solid Waste Awareness*, August 1990 (EPA530-SW-90-005). Some activity ideas were based on existing solid waste educational materials. These documents can also serve as excellent sources of additional activities for use in the classroom. EPA credits

the following publications and provides information that might be helpful when ordering resources, when available:

Air, Land & Water Teachers' Manual, Illinois Environmental Protection Agency, Office of Public Information, 1021 North Grand Avenue, East, P.O. Box 19276, Springfield, Illinois 62794-9276. *To order:* Phone: 217 782-3397. No cost.

A-Way With Waste, Fourth Edition, Washington State Department of Ecology, Air Quality Program. *To order:* Department of Ecology, Publications Office, P.O. Box 47600, Olympia, Washington 98504-7600. Phone: 360 407-7472. <ecypub@ecy.wa.gov>. Publication # 97-200.

Closing the Loop: Integrated Waste Management Activities For School and Home, K-12, The Institute for Environmental Education and the California Integrated Waste Management Board, 1993. 18544 Haskins Road, Chagrin Falls, Ohio 44023-1823. Phone: 216 543-7303. *To order:* Public Education and Assistance Section, 8800 Cal Center Drive, Mail State 5, Sacramento, California 95826. Cost: $15.00.

"Luscious Layered Landfill" activity, Delaware Solid Waste Authority. *To order:* 1128 S. Bradford Street, P.O. Box 455, Dover, Delaware 19903-0455. Phone: 800 404-7080. No cost.

Environmental Education: Compendium for Integrated Waste Management, California Department of Education, California Integrated Waste Management Board and California Department of Toxic Substances Control, June 1993. *To order:* Hotline Coordinator/Public Affairs Office, California Integrated Waste Management Board, 8800 Cal Center Drive, Sacramento, California 95826. <www.ciwmb.ca.gov/publications/default.asp>. CIMWB Pub # 502-93-001. No cost.

Environmental Protection: Native American Lands, Grades 1-12, Second Edition, The Center for Indian Community Development, Humboldt State University, Arcata, California 95521. *To order:* Phone: 707 826-3711.

Forever Green: A Recycling Education Program for Grade 3, Fort Howard Corporation, Green Bay, Wisconsin.

4th R Recycling Curriculum, San Francisco Recycling Program, 1145 Market Street, Suite 401, San Francisco, California 94103. *To order:* Phone: 415 554-3400. Cost: $10.00.

4Rs Project: A Solid Waste Management Curriculum for Florida Schools, The Florida Department of Education, July 1990.

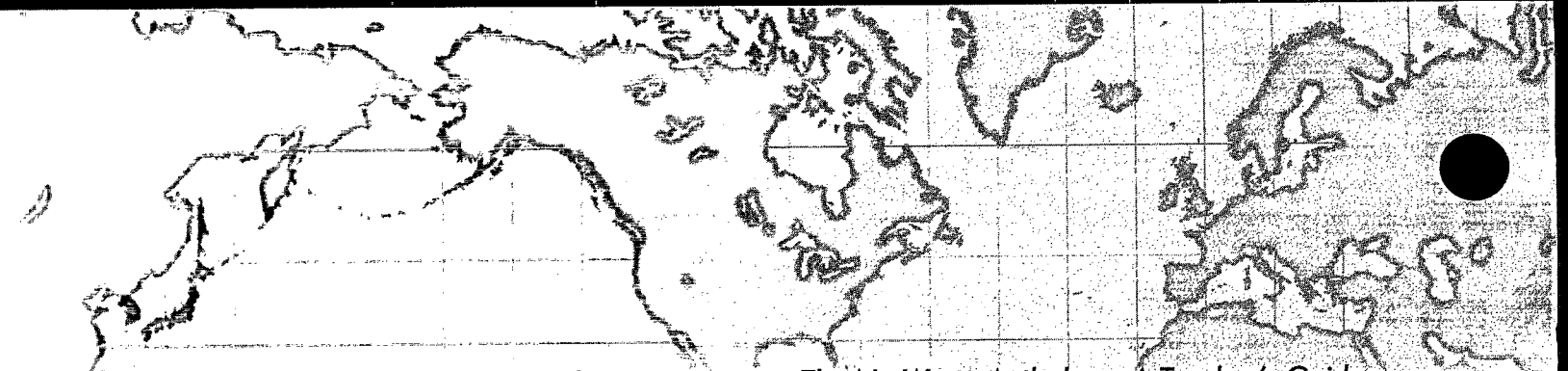
Here Today, Here Tomorrow (Revisited): A Teacher's Guide to Solid Waste Management, State of New Jersey Department of Environmental Protection and Energy, Information Resource Center, 432 E. State Street, CN 409, Trenton, New Jersey 08625. No longer available.

LifeLab Science Program Web site, Santa Cruz, California, <http://www.lifelab.org>.

Mister Rogers: Activities for Young Children About the Environment and Recycling, Family Communications, Inc., 1990. *To order:* Keep America Beautiful, Inc., 9 W. Broad Street, Stamford, Connecticut 06902. Phone: 203 323-8987.

Mystery of the Cast Off Caper: 4-H Solid Waste Leader's Curriculum Guide, North Carolina Cooperative Extension Service, 1992. *To order:* Contact your local Extension Service Center.

Nature's Recyclers Activity Guide, Wisconsin Department of Natural Resources, 1991. Bureaus and Solid Waste and Information and Education, P.O. Box 7921, Madison, Wisconsin 53707. *To order:* Phone: 608 267-0539 or <www.dnr.state.wi.us/org/aw/wm/publications/recycle/index.htm>.



Planet Patrol: An Environmental Unit on Solid Waste Solutions for Grades 4-6, The Procter & Gamble Company, One Procter & Gamble Plaza, Cincinnati, Ohio 45202. *To order:* Household Hazardous Waste School and Youth Program, 130 Nickerson Street, Suite 100, Seattle, Washington 98109. Phone: 206 263-3082. <haz.waste@metrokc.gov>. TD 779.P55.

Recycling Study Guide and K-3 Supplement to the Recycling Study Guide, Wisconsin Department of Natural Resources, 1993, 1990. Bureaus and Solid Waste and Information and Education, P.O. Box 7921, Madison, Wisconsin 53707. *To order:* Phone: 608 267-0539 or <www.dnr.state.wi.us/org/aw/wm/publications/recycle/>.

Rethinking Recycling: An Oregon Waste Reduction Curriculum/Teacher Resource Guide, Oregon Department of Environmental Quality, 1993. *To order:* Department of Environmental Quality's Solid Waste Policy and Program Development Section, 811 SW Sixth Avenue, Portland, Oregon 97204. 503 229-5913, Phone: 800 452-4011 (in Oregon). Cost: $6.00.

The No Waste Anthology: A Teacher's Guide to Environmental Activities K-12, California Environmental Protection Agency, Department of Toxic Substances Control, 400 P Street, P.O. Box 806, Sacramento, California 95812-0806. *To order:* Household Hazardous Waste Program, NH Department of Environmental Services, 6 Hazen Drive, P.O. Box 95, Concord, New Hampshire 03302-0095. Phone: 603 271-2047. <hhw@des.state.nh.us>.

Trash Today, Treasure Tomorrow, University of New Hampshire Cooperative Extension, 1990. *To order:* Office of State Planning, 2-1/2 Beacon Street, Concord, New Hampshire 03301-4497. Phone: 603 271-1098. Cost: $12.50.

EPA published ***A Resource Guide of Solid Waste Educational Materials***, January 1998, to help teachers locate a selection of curricula, activity guides, videos, and Internet sites that contain solid waste educational information. It is available free of charge and can be ordered by calling 800 424-9346. Request document number EPA530-B-97-004.

Visit the Kids' Page

EPA continually adds new Internet activities to the Office of Solid Waste "Kids' Page." You'll find an interactive alien expedition to Earth, a crossword puzzle, a coloring book, a comic book, and other games and activities. Check the site periodically for new enrichments for your students.

www.epa.gov/osw/kids.htm

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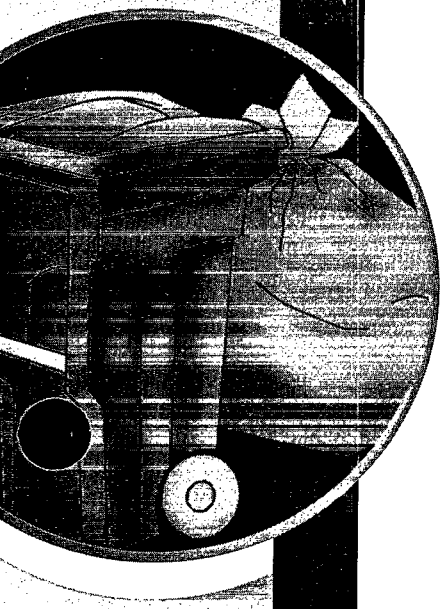

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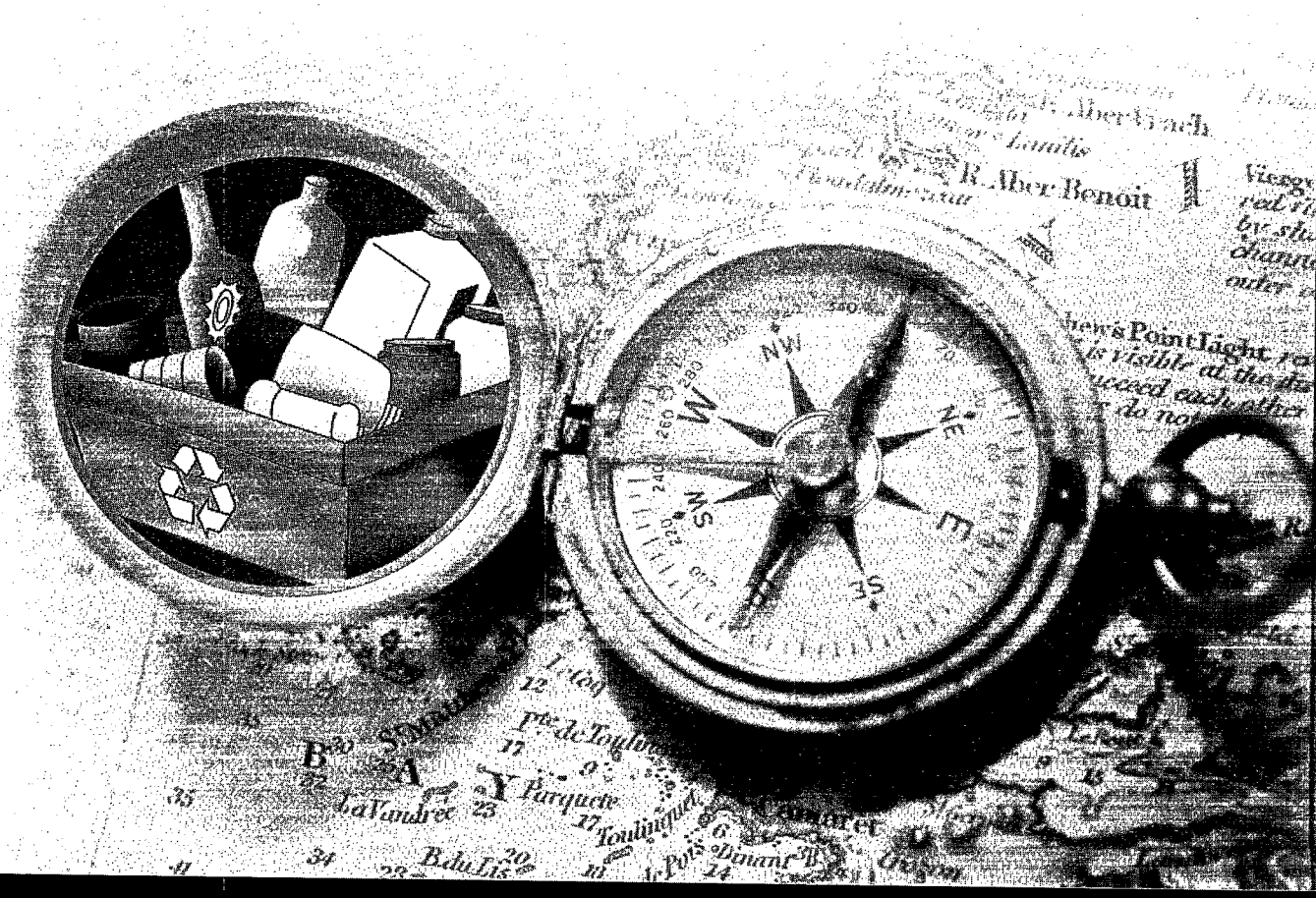
UNIT 1

Product Life Cycles

Where Products Come From, How They're Made, and the Waste They Produce

In this unit, teachers and students will develop a foundation to understand the importance of managing waste properly. Students will learn where the products they use every day come from and how much and what kind of waste these products create. They also will learn that waste is not only created by throwing things away, but it also can be produced by human activities such as mining raw materials from the ground and manufacturing goods in factories. This part of the resource will help students understand why it is important to prevent waste in the first place, recycle, compost, and reuse—activities they will learn more about in the next unit.



CHAPTER 1

Natural Resources

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Grade • Subject • Skills Index

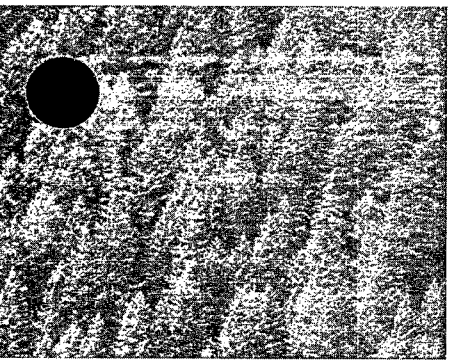
Activity Name	Nature Romp	An Ecosystem Escapade	Dr. Seuss and Resource Use	Sources of Resources	How Many People Does It Take to Ruin an Ecosystem?
Grade Range					
K	✔				
1	✔	✔			
2		✔	✔		
3		✔	✔		
4					
5				✔	✔
6				✔	✔
Subjects Covered					
Math					
Science	✔	✔	✔	✔	✔
Language Arts			✔		
Social Studies				✔	✔
Art	✔	✔			
Health					
Skills Used*					
Communication	✔	✔		✔	✔
Reading			✔		
Research				✔	
Computation					
Observation/ Classification	✔			✔	
Problem Solving			✔	✔	
Motor Skills	✔	✔			✔

*See Glossary of Skills for more details.

Natural Resources

What Are Natural Resources?

Natural resources are useful materials from the Earth, such as coal, oil, natural gas, and trees. People depend on natural resources for basic survival and use them as **raw materials** to manufacture or create a range of modern conveniences. Water and food provide humans with sustenance and energy, for example, and fossil fuels generate heat as well as energy for transportation and industrial production. Many of the same natural resources used by people are important to plants and wildlife for survival as well.



Virgin Versus Recovered Resources

Resources used for the first time are considered **virgin resources**, and their extraction, processing, and use requires a great deal of energy and can create pollution. **Resource recovery** is a practice that conserves natural resources by extracting used materials (e.g., paper, glass, and metals) and energy from **municipal solid waste** and reprocessing them for reuse. For example, a company can create plastic from oil, a virgin natural resource, or it can use recovered plastic from recycling programs. If a company uses recovered plastic, it is actually saving materials that would otherwise become waste, helping to prevent the depletion of natural resources, conserving energy, and preventing pollution that would have been created in the extraction and processing of oil from the ground.

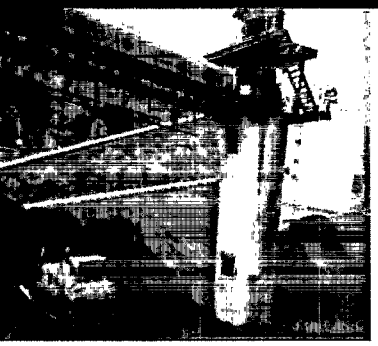
In addition to the benefits already discussed, using recovered resources reduces threats to **biodiversity**. Natural resource extraction, along with other human activities, increases the rate at which species of plants and animals are now vanishing. Diminishing the Earth's biodiversity has a substantial human cost because wild species and natural ecosystems are important resources. For example, some economists estimate that the lost pharmaceutical value from plant species extinctions in the United States

Key Points

- Natural resources are vital to all forms of wildlife and the ecosystems in which they live.
- Human beings use natural resources for such modern conveniences as electricity, transportation, and industrial production, as well as basic survival.
- Rapid population growth, a higher standard of living, and technology all contribute to increased use of natural resources.
- Extracting, processing, and using natural resources can cause environmental problems, such as the disruption or destruction of ecosystems; a decrease in biodiversity; and land, water, and air pollution.
- Using renewable natural resources impacts the environment less than using nonrenewable resources because their supply can be regenerated.
- Using recovered resources prevents natural resources from being wasted.
- Using recovered rather than virgin resources decreases greenhouse gas buildup, which can result in global climate change.
- Resource recovery and conservation, as well as buying recycled products, are emerging trends that reduce consumption of natural resources.

Biodiversity

Biodiversity refers to the variety of organisms that live on Earth. Supporting so many different organisms requires the conservation of the natural resources they need to survive. Using natural resources can not only deplete the Earth of the resources themselves, but by destroying critical habitats, it can also drive some species to extinction, ultimately reducing biodiversity.



alone is almost $12 billion. Reducing the land disturbance and pollution associated with virgin materials extraction by using recovered materials, therefore, helps stop the degradation of the Earth's ecosystems.

Renewable Versus Nonrenewable Resources

Some natural resources are nonrenewable and some are renewable. **Nonrenewable resources** are those that become depleted more quickly than they naturally regenerate. One example of a nonrenewable resource is mineral ore. Once mined and used completely, it is gone forever, for all practical purposes, because it will take millions of years to regenerate. **Renewable resources** can be replenished at approximately the same rate at which they are used (for example, sun and wind, which can be used to provide energy).

Products Made From Natural Resources

People use an abundance of resources to survive in a continually developing world. Globally, however, some people live simpler lifestyles than others and therefore use fewer resources. The following table lists some natural resources and the products and services people produce from them.

Natural Resource	Product/Service
Trees	Paper, furniture, fuel
Cotton plant	Clothing
Oil/Petroleum	Plastic, fuel
Gas	Fuel
Coal	Fuel
Iron ore	Steel products (cans, bridges)
Bauxite ore	Aluminum products (cans, car parts)
Gold	Jewelry, dental material
Copper	Wire, coins, electrical equipment
Manganese	Steel, cast iron
Cobalt	Steel, jet engine parts, cutting tools
Platinum	Air pollution control and telecommunications equipment, jewelry
Chromium	Stainless steel, green glass, gems (rubies and emeralds), leather treatment
Diamonds	Jewelry, mechanical equipment

Renewable or Nonrenewable—or Both?

Some resources can be considered both renewable and nonrenewable. Trees are considered a renewable resource because their supply can be replenished (e.g., more trees can be planted). If, however, an entire forest of 400-year-old trees is cleared and a new-growth forest is planted, the supply of old-growth trees has not been replenished. It takes many generations for an old-growth forest to mature, and so, old-growth trees are considered nonrenewable. Trees are a complex resource because as a forest, their environmental and economic contributions often depend on their age. For example, clearing a forest of 200-year-old Redwoods, unlike clearing a forest of new-growth pines, diminishes high levels of biodiversity only developed in old-growth forests.

What Are the Benefits of Natural Resources?

Renewable resources offer a number of environmental and economic benefits over nonrenewable resources. One obvious benefit is the infinite supply of renewable resources—they cannot be depleted. Another benefit of using renewable resources is self-reliance. A country that can provide its own renewable resource, such as solar-powered electricity, need not rely on other countries for an energy source. Additionally, renewable resources offer communities relief during periods of recovery from natural disasters. When communities lose standard services that require the use of natural resources (e.g., electric power or natural gas), renewable resources, such as wind and solar energy systems, are used to provide these services until the usual methods of achieving service can be restored. Following the 1992 Hurricane Andrew, for example, a south-Miami subdivision continued to have working streetlights because they were all photovoltaic (PV)-powered. The areas became neighborhood gathering spots for a community left without electricity following the storm. In several cases, homes equipped with PV systems were able to keep minimal services running and became emergency shelters for surrounding residents without power.

Greenhouse Gas: A gas that absorbs and retains heat from the sun. Greenhouse gases include methane, ammonia, sulfur dioxide, and certain chlorinated hydrocarbons. A buildup of these gases traps warmth in the Earth's atmosphere, changing the global climate.

Global Climate Change: Natural- or human-induced change in the average global temperature of the atmosphere near the Earth's surface.

What Are the Challenges of Using Natural Resources?

Extracting, processing, and using natural resources creates air, water, and land pollution, which can cause global environmental problems. For example, carbon dioxide, which is produced from **deforestation**, and from burning coal, oil, and natural gas, is a critical **greenhouse gas**. Many scientists believe that the buildup of greenhouse gases in the atmosphere can cause global climate change. Over time, this condition could pose serious dangers around the world, prompting such disasters as flooding, drought, and disease.

In addition, extracting and using resources can disturb relationships within **ecosystems**. For example, the effects of clearing an old-growth forest for wood can destroy habitats used by

What Are Ecosystems?

Ecosystems are self-regulating communities of plants and animals that interact with one another and with their nonliving environment. Examples of ecosystems include ponds, woodlots, and fields.

Organisms within an ecosystem are connected by energy. Individuals in a community feed on each other, thus transferring energy along a **food chain** or **food web**. In a food chain, energy is transferred from one organism to another in a linear form. For example, the sun provides fuel for a fig tree, which provides sustenance for wasps. The wasps are a food source for spiders, which are eaten by birds. More complex food webs can be thought of as a network, involving energy transfers among several organisms.

many animals, forcing them to find homes elsewhere. If these animals leave an ecosystem, further disturbances can occur within plant and animal populations that depend on these species.

Additionally, with the absence of tall trees in the forest, lower vegetation would lose shade provided by the upper canopy, resulting in increased exposure to sunlight and decreased moisture. Changes in an ecosystem's climatic conditions will eventually change vegetation type, which will alter the kinds of animals that can exist in that community. Over time, if enough ecosystems are affected, an entire community type can change (e.g., over-harvested fields can turn into deserts).

Natural Resource Consumption Facts

- The United States uses one million gallons of oil every 2 minutes.
- Every American uses about 47,000 pounds of newly mined materials each year.
- A television requires 35 different minerals, and more than 30 minerals are needed to make a computer.
- Over the past 40 years, global consumption of wood as industrial fuel rose by nearly 80 percent. North America alone accounts for about 40 percent of both production and consumption of wood as industrial wood products.
- In 1998, each person in the United States threw away an average of 4.46 pounds of waste each day.

(Sources: Natural Resources Defense Council, 1996; National Mining Association, 2000; World Resources Institute, 2000; EPA, 1998.)

Population growth, increasing affluence, technological change, and urbanization are all responsible for rapidly rising resource consumption all over the world. The relationship between the population growth and increased resource use varies among developed and undeveloped nations. For example, according to the Department of Energy, residents of the industrialized world comprise only 20 percent of the world's population, yet consume 86 percent of its iron and steel, and 76 percent of its timber. Despite the inconsistent relationship between resource use and developed and undeveloped nations, it is apparent that worldwide, more people use more resources. With population, technology, and lifestyle demands growing exponentially, people are using increasing amounts of many natural resources.

Innovative Technology Using Recovered Materials

Plastic lumber was developed to utilize low-cost materials such as plastic grocery bags and wood chips or sawdust. Used as a wood alternative, plastic lumber offers several advantages over using lumber; it is long lasting, requires limited upkeep, and resists warping and decay. One example of how using plastic lumber can conserve and recover resources is a bridge at Ft. Leonard Wood, Missouri. The construction of the plastic lumber bridge utilized 13,000 pounds of mixed plastics that otherwise would have gone to waste. This exercise in reuse translates into significant natural resource conservation.

Emerging Trends

Increasing demands for natural resources have spurred new methods for conserving existing resources. More and more companies are developing new and innovative technologies that use recycled materials as raw materials in the manufacture of products. Some steel producers, for example, use minimills and a manufacturing process that uses virtually 100 percent recovered scrap steel as the raw material.

Recovery—In Action

- More than 65 percent of the steel produced in the United States is made from recovered steel.
- The average aluminum can contains an average of 50 percent post-consumer recycled content.
- By 1997, the paper industry relied on recovered paper for 45 percent of its feedstock.
- Using recovered aluminum cans saves 95 percent of the energy required to make the same amount of aluminum from bauxite, its virgin source.
- Recycling and reuse of 2,000 pounds of paper saves 7,000 gallons of water and 380 gallons of oil.

(Sources: Steel Recycling Institute, 2000; Aluminum Association, 2000; American Forest and Paper Association, 2000; The Can Manufacturers Institute, 1997; Weyerhaeuser Company, 1999.)

How Can You Help?

An increasing number of individuals are also practicing **conservation** methods by using less—such as buying products with less packaging. (See the Teacher Fact Sheets titled *Recycling* on pg. 73 and *Buying Recycled* on page 79). Certain lifestyle changes, such as composting food scraps rather than buying fertilizer (see the Teacher Fact Sheets titled *Source Reduction* on pg. 133 and *Composting* on page 109), also preserve natural resources. Other suggestions for ways to practice conservation of natural resources are as follows:

- Reduce waste by reusing paper grocery and lunch bags or eliminate waste by using cloth bags.
- Donate old toys, clothes, furniture, cars, and other items to organizations such as the Salvation Army rather than throwing them in the garbage.
- Close the recycling loop by purchasing recycled-content products and packaging.

Additional Information Resources:

Visit the following Web sites for more information on natural resources and solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA Office of Solid Waste composting site: <www.epa.gov/epaoswer/non-hw/compost/index.htm>
- World Resources Institute: <www.wri.org>
- Natural Resources Defense Council: <www.nrdc.org>
- United States Department of Energy's National Renewable Energy Laboratory: <www.nrel.gov>
- United States Department of Energy's Center of Excellence for Sustainable Development: <www.sustainable.doe.gov>

To order the following document on municipal solid waste, call EPA toll-free at 800 424-9346 (TDD 800 553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *A Collection of Solid Waste Resources*—CD-ROM

Nature Romp

Science

Art

Objective

To gain an appreciation of nature and the environment.

Activity Description

Students will take a nature walk, make observations, and collect natural objects for an art activity.

Materials Needed

- Bags (e.g., old lunch or grocery bags)
- Paint
- Smocks
- Crayons
- Glue
- Scissors
- Pens or pencils
- Construction paper
- Large sheet of paper

Key Vocabulary Words

Nature
Environment
Habitat

Duration

2 hours

Skills Used

Communication
Observation/classification
Motor skills

Activity

Step 1: Draw a chart on a large piece of cardboard or poster board with headings that describe several types of natural objects that students could find outdoors. Headings might include rocks, leaves, flowers, bugs, animals, nuts (see below). Attach a sample of each of these objects (e.g., for flower, it can be a flower petal or seed). Discuss each of the objects and tell students their mission will be to find evidence of these items in the outdoors. Examples of the types of evidence students might bring back that would fit into the category headings could include pebbles, leaves or needles, seeds, acorns, feathers, and twigs.

Step 2: Bring students outdoors into the school yard, a field, a patch of woods, a garden, or other natural area, no matter how

Rocks	Leaves	Flowers	Bugs	Animals	Nuts

small. Distribute a bag to students, and tell them they are on a scavenger hunt to find evidence of the items discussed in class. Please ensure that students only collect items that have fallen to the ground or are dead; no live plants, flowers, insects, or other organisms should be collected, nor should bark be peeled off trees. Teachers might have to work closely with students to help them locate and identify appropriate items.

Step 3: While students are collecting objects, ask them for their observations. You might want to talk about their discoveries, focusing on colors, senses, seasons, or animal lives (e.g., hibernation, food).

Step 4: Regroup in the classroom and help students spread everything they've collected on a table. Ask the students to categorize their items into the headings on the chart you prepared earlier. Compare the different colors, sizes, and shapes of each of the items. Group everyone's objects together and attach them to the posterboard, or let students keep their own pile and proceed to Step 5.

Step 5: Prepare for painting and gluing by putting on smocks and gathering the art supplies (e.g., paper or cardboard, glue, crayons, paint, construction paper, and scissors). Ask students to create artwork, using objects they collected, that depicts the natural environment they just explored. Students can glue natural objects directly onto the paper, or they can create a sculpture. Students could also create cut-outs of animals or plants that they observed.

Step 6: Allow the artwork to dry and hang posters around the classroom to bring a little of the environment indoors!

Teachers: Please note that many federal and state land management agencies prohibit or discourage collecting living or non-living items in a natural environment. Depending on your situation, you might want to consider directing students to draw or paint the live organisms they find as a substitute for the real thing.

Assessment

1. Ask students if they found anything outside that they had never seen before. If so, can they explain what it is?
2. Review some of the specific items found and what their purpose is.
3. Ask students to share what they like best in nature.

Enrichment

1. Schedule a day trip to a local nature center where students can participate in further outdoor education.
2. Adopt a specific tree in your schoolyard and observe how it changes through the seasons. Have students draw the tree during different seasons.
3. Participate in an environmental education workshop and obtain copies of the conservation/environmental education activity guides entitled *Project WILD K-12*, *Project WILD Aquatic Education*, or *Project Learning Tree*. Project WILD's state coordinators and their facilitators conduct workshops (usually 6 hours long) for educators within their state. The activity guides are provided to those who participate in the workshops. They include numerous indoor and outdoor hands-on activities related to the environment, with a focus on wildlife. Other classroom materials are available without participating in the workshops. For more information, and to find out how to get information in your state, visit the Web site <www.projectwild.org/main.html>. You can also contact the Project WILD National Office at 707 Conservation Lane, Suite 305, Gaithersburg, MD 20878, Phone: 301 527-8900, Fax: 301 527-8912; or e-mail: info@projectwild.org.

An Ecosystem Escapade

Objective

To learn how animals and plants depend on each other in ecosystems.

Activity Description

Students will role-play elements of a food web to illustrate the connections in ecosystems.

Materials Needed

- Paper or cardboard
- Crayons or markers
- Scissors and string
- Hole-punch

Subjects Covered

- Food chain
- Food web
- Ecosystem

Duration

- 1 hour

Skills Used

- Communications
- Motor skills

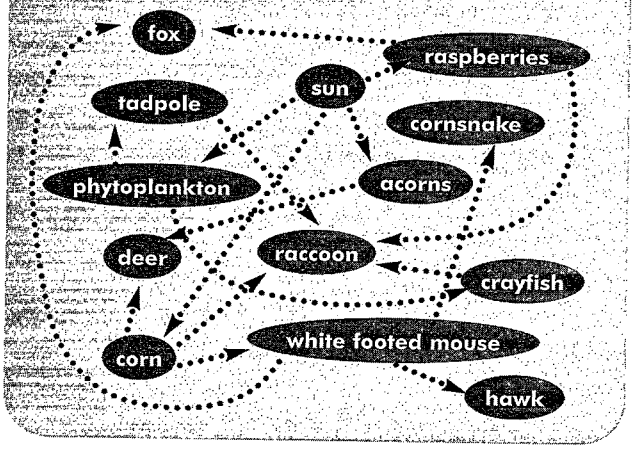
Activity

Step 1: If possible, take the students outside into a natural environment, such as woods (otherwise, ask them to use their imaginations and conduct the lesson indoors). Explain what an ecosystem is and what types of ecosystems are in your area. Ask them to identify different animals and plants that they see when they go outside. Discuss in a group what all animals and plants have in common (i.e., that they need to eat). Explain how some animals eat plants, some plants eat animals (e.g., a Venus Fly Trap), and some animals eat other animals. Ask the students what they eat.

Step 2: Explain that animals and plants rely on each other for food and for survival. All of the plants and animals working together, eating each other and being eaten, is part of nature and can be

Sample Food Chain:
(in an Eastern U.S. deciduous wooded ecosystem)

Sample Food Web:
(in an Eastern deciduous wooded ecosystem)

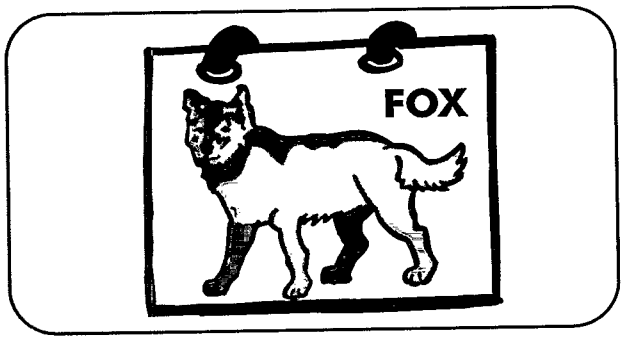


Arrows indicate the direction that energy is transferred.

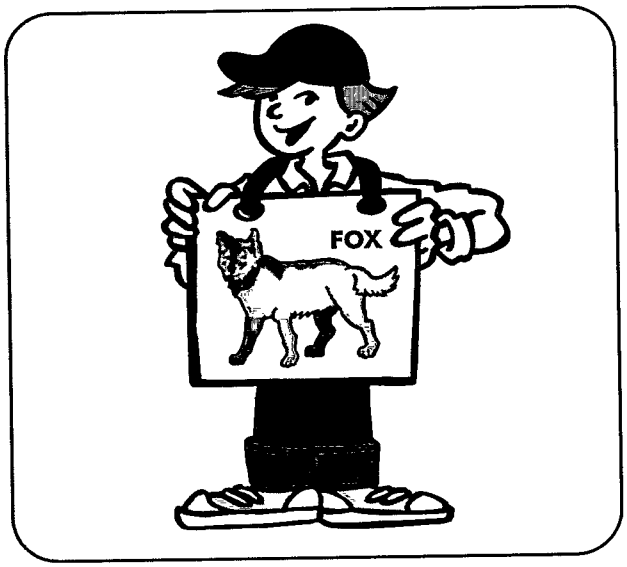
described as "food chains" or "food webs." Show the students an example on the board (see sidebar for examples of food chains and food webs).

Step 3: Based on the animals and plants that are named by the students, create a food web on the board and have students help you decide which animals and plants eat each other.

Step 4: Have each student pick one animal or plant in the ecosystem described on the board. Instruct each student to draw a picture on a piece of paper or cardboard of their animal or plant and write its name near the picture.



Step 5: Using a hole-punch and string, help students create a placard to identify them as a particular animal or plant.



Step 6: Facilitate an exercise with the students in which they find the animal or plant that they eat and link hands with that person. If the food web is created properly, many people should be holding hands.

Assessment

1. As Step 6 is being conducted, ask students to remember what eats what. If there is more than one option, acknowledge students when they say a correct answer, even if no one in the class is role-playing that particular plant or animal.
2. Ask students why animals eat other animals or plants.
3. Ask students what would happen to the plants and animals in the food web if one plant or animal disappeared. Explore with students reasons why an animal or plant would disappear.

Enrichment

1. Create illustrations and placards exemplifying a chain of foods that the students eat. Then link hands to create one or more chains (for example, people eat hamburger, which is made from cows, which eat grass).
2. Teach the students the words to "This Land Is Your Land" and sing it as a class. Discuss some of the lyrics that describe particular ecosystems (e.g., redwood forests).
3. Tell students the different types of ecosystems that exist in your geographic location, such as streams, ponds, forests, deserts, and meadows. Have each student pick one and draw a picture of it, including animals and plants that live in it. If possible, have students collect items in nature, such as leaves, acorns, bones, bark, to include in their artwork.

Dr. Seuss and Resource Use

science

language arts

Objective

To learn about resources and the potential negative impacts humans can have on the environment through overconsumption.

Key Vocabulary Words

- Natural resources
- Pollution
- Ecosystem
- Consumption

Activity Description

Students will listen to the teacher read *The Lorax* by Dr. Seuss. The teacher will then show the class products that exemplify reduced resource consumption.

Duration

2 hours

Materials Needed

- *The Lorax* by Dr. Seuss

Skills Used

- Reading
- Problem solving

Activity

Day 1: Listening Exercise

Step 1: Introduce and discuss the concept of natural resources and product consumption with students (refer to the Teacher Fact Sheet titled *Natural Resources* on page 5). Review vocabulary words above. Note how humans continue to consume more and more products, which takes a toll on the environment.

Explain that ecosystems are comprised of many different interrelated components, such as different plant and animal species. Add that when one part of an ecosystem is disturbed, it impacts the entire ecosystem.

Step 2: Take students to a quiet area outside where they can sit comfortably and listen without distractions. Have students sit in a circle. Once settled, ask students to close their eyes and take three long deep breaths to help them relax.

Step 3: Once students are calm and attentive, read *The Lorax* out loud. In this story, a character called the "Once-ler" cuts down "Truffula" trees for their valuable silk tufts and uses them to make "thneeds." Due to increasing thneeds sales, the Once-ler builds a factory and invents an axe that can cut down four trees at once. The Lorax, a wise creature of the forest, recognizes the potential harm this could have on the Truffula tree forest ecosystem. He speaks up to defend the trees, animals, air, and water that the Once-ler is destroying in pursuit of more money and to satisfy those who want thneeds. Eventually all the Truffula trees are depleted, and the Once-ler can no longer produce thneeds. The once beautiful site is left contaminated with polluted air and water.

Journal Activity

Remind students that the Lorax spoke for the trees, "for the trees have no tongues." Ask students to choose one thing in the environment that is in jeopardy and cannot speak for itself and defend it. Why is it in jeopardy?

Step 4: Discuss the story with the students. Begin by asking them why the Once-ler is called the "Once-ler." Evaluate why the Once-ler had to use all the Truffula trees and ask the students to speculate why he would not listen to the Lorax. Ask the students if they can suggest a way for the Once-ler to make thneeds without destroying the ecosystem in which the Lorax lived.

Step 5: Have students suggest "thneeds" that they often use (e.g., clothes, food, books). Instruct students to go home that night and think about how they can consume less resources while still using their thneeds. One example is buying used clothing instead of new clothing. Instruct students to bring in their thneed for a "show and tell" activity the following day.

Day 2: "Show and Tell"

Step 1: Have students present their thneed and explain their solution for consuming less resources while using their thneed. If the student cannot think of a solution, ask the class to contribute its ideas.

Assessment

1. Ask the students why the Once-ler cut down the Truffula trees.
2. Ask the students why the Brown Bar-ba-loots have to leave the forest after the Once-ler starts his thneed production. Could something like this happen in real life? How?
3. Have students list three ways the Thneed factory caused problems for the Truffula Tree forest and its residents.
4. Have students explain what the Lorax's message "Unless" means (answers should include the need for future generations to protect and care for the Earth).

Enrichment

1. Break students into groups of approximately five students. Have students rewrite *The Lorax* so that the Truffula tree forest and its inhabitants are saved. Students can use this to develop a script and act out their own story in front of the class.
2. Instruct students to create a collage of their needs and wants, labeling them "thneeds" and "thwants," by cutting pictures out of magazines. Once the collages are complete, ask the students to tell the class about opportunities to use less resources with the thneeds and thwants.

Sources of Resources

Objective

To identify natural resources as renewable or nonrenewable; to learn where resources come from; and to understand how overconsumption of limited supplies can be problematic.

Activity Description

Students will research resources, investigating their sources and uses. They will present conclusions to the class and identify on a map where the resource is most often found.

Materials Needed

- Wool sweater
- Plastic milk jug
- Metal can
- Glass bottle
- Plastic boot or raincoat
- Fruit and/or vegetables
- Wood object (chair, ruler, etc.)
- Cotton T-shirt
- Paper
- Dairy product (egg, cheese, milk, etc.)
- Leather (belt, shoe, purse, etc.)
- Pushpins
- Paper (used to make small labels/tags)
- Scissors
- Pens
- World map

Subjects Covered

- Natural resources
- Renewable
- Nonrenewable
- Raw materials
- Consumption

Duration

- 1 hour

Skills Used

- Communication
- Research
- Observation/classification
- Problem solving

science

social studies

Activity

Step 1: Display all of the materials from the "Materials Needed" list above except for the last five items. Discuss the concept of natural resources with the students and ask them to identify what each of the objects on display are made from (refer to Teacher Fact Sheet titled *Natural Resources* on page 5). List their answers on the board. Use the list to define and explain the key vocabulary words.

Valuable Natural Resources

Aluminum	Nickel
Chromium	Oil
Coal	Petroleum
Cobalt	Platinum
Corn	Silver
Diamonds	Tin
Fish	Wheat
Fresh Water	Wool
Gold	Zinc

Journal Activity

Ask students to list the kinds of natural resources they use frequently. Are they renewable or nonrenewable? Ask students to write about what they would do if the world supply of the resource ran out.

Step 2: Have a brainstorming session with students to identify well-known resources such as those listed in the "Valuable Natural Resources" sidebar. Try to come up with at least as many resources as there are students in the class. Write the list on the chalkboard.

Step 3: Have each student choose a natural resource from the list.

Step 4: Instruct students to research their chosen resource. They should use library and Internet resources to investigate the dominant sources and uses for their resource. Students should also research consumption of their resource and analyze whether their resource might become depleted in the near future.

Step 5: Display a large map of the world in the front of the classroom.

Step 6: Have students write the name of their resource on several small pieces of paper.

Step 7: Have students present information about their resource to the class, discussing their research conclusions. Students should begin their presentation by telling the class what their resource is and where it is most typically found. Students should pin the paper that labels their resource on the map at the appropriate regions. Additionally, students should discuss whether the resource is renewable or nonrenewable and tell the class some of the resource uses and any associated consumption issues.

Assessment

1. Ask students to identify the natural resources used to make items, other than those previously studied. Have students think about their house, family car, room, school, or other familiar objects in their lives.
2. Test students' memory of where some of the assigned resources come from. Take the pins out of the map and have students place the pins at the proper geographic locations as you call out the resources.
3. Ask students to explain and discuss the importance of monitoring resource consumption. Also, discuss why it is important to develop and discover alternatives to certain resources.

Enrichment

1. Have students research, via the Internet or the school library, information on our global population and specific resource quantities. Have them calculate and record figures to determine the approximate future supply of particular resources.
2. Have students pick their favorite resource and identify ways to conserve it. With this information, have students write and act out a skit that exemplifies resource conservation practices.
3. Conduct a geology lesson that incorporates a discussion of the formation of some common natural resources (e.g., coal, petroleum, diamonds). Ask students why all resources are not located right in their backyards. Discuss what this means in terms of resource availability (e.g., how we get resources from other countries).

How Many People Does it Take to Ruin an Ecosystem?

science

social studies

Objective

To learn how animals and plants depend on each other in ecosystems and how human activities can impact ecosystems.

Subjects Covered

- Food chain
- Food web
- Ecosystem

Activity Description

Students will role-play elements of a food web to illustrate the connections in ecosystems and will respond to real-life scenarios that impact ecosystems.

Duration

1 to 2 hours

Materials Needed

- Red stickers
- Green stickers
- Black stickers
- Cardboard
- String

Skills Used

- Communications
- Motor skills

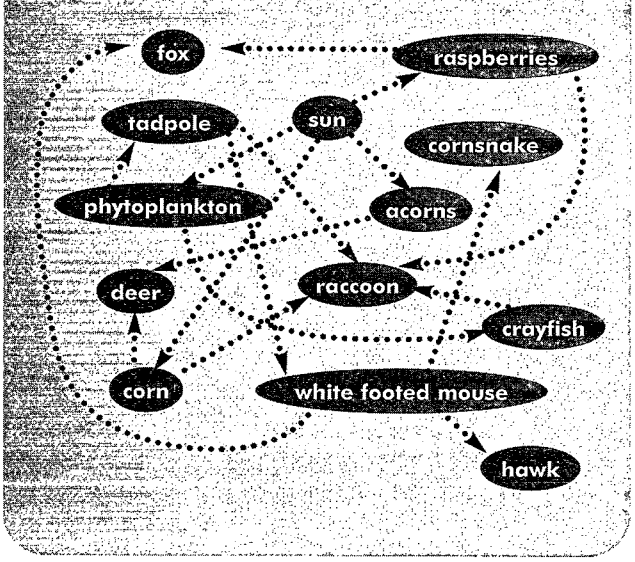
Activity

Step 1: Discuss ecosystems with students and identify the types of ecosystems that exist in your geographical area. Select an ecosystem to study (e.g., forest, meadow, stream, pond).

Step 2: As an in-class exercise with students, brainstorm some of the animals and plants that make up that ecosystem. Have a student write everything on the board and have the class create links between the items that plants and animals eat and those that eat them. The result should be a complex food web (see example in the side bar). Leave the food web on the board until the next day.

Step 3: Assign each student to a particular plant or animal that exists in a

Sample Food Web:
(in an Eastern U.S. deciduous wooded ecosystem)



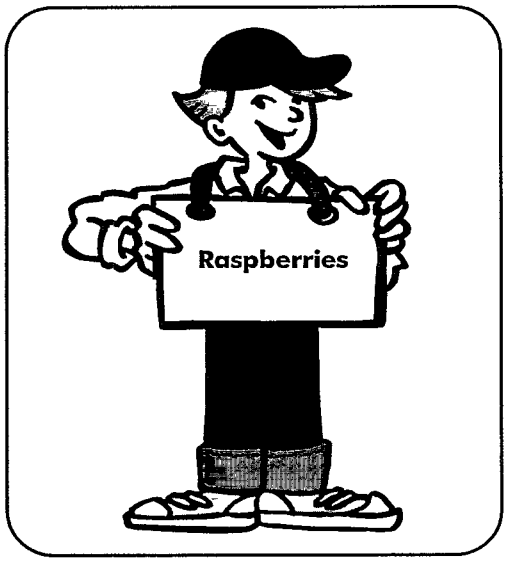
Arrows indicate the direction that energy is transferred.

Journal Activity

Ask students to describe a natural place that is special to them. Have them write about what lives there and why it is so magical. Or ask them to write a poem that is in the shape of something in nature.

specified ecosystem. Have them research (either at the school library or on the Internet) what the plant eats, what eats it, and any factors that are necessary in its habitat for survival. Have students tell the class what they found, in 5 minutes or less, modifying the existing food web as you go.

Step 4: Have students create a placard to identify themselves as a certain plant or animal. All students should start off with a green sticker on their placard, indicating that the population of their plant or animal species is healthy.



Step 5: Facilitate an exercise in which each person holds hands with the person wearing a sign of the animal or plant that they eat. The result should be a tangled web of students, holding several people's hands.

Step 6: Now, introduce some human-created scenarios that would affect this ecosystem (see examples below). When an animal or plant is affected, a red or black sticker must be placed on the person's placard. For example, in a meadow ecosystem, a scenario might be that a farmer applies pesticides to the meadow, which kills off the Monarch Butterflies. Whomever is playing the role of the Monarch Butterfly would put a black sticker over top of the green sticker (and should be removed from the web). Students should be asked to identify what other species are affected by the disappearance of the Monarchs in this ecosystem. Those that are affected (that depend on the Monarch for food or that serve as prey for the Monarch) should place a red sticker over top of the green sticker, indicating the species is in trouble.

Sample Scenarios of Human Activities That Could Affect Ecosystems:

- Pesticide-containing runoff makes its way into a stream from which animals drink.
- A household dumps used oil in the storm drain, which empties out into a bay.
- An old-growth forest is clear-cut.
- Hazardous waste from a factory is dumped into the river.
- Acid rain from factories kills off trees in a forest 200 miles away.

Step 7: Introduce several detrimental scenarios until the students decide that the ecosystem is no longer viable and should be considered destroyed.

Assessment

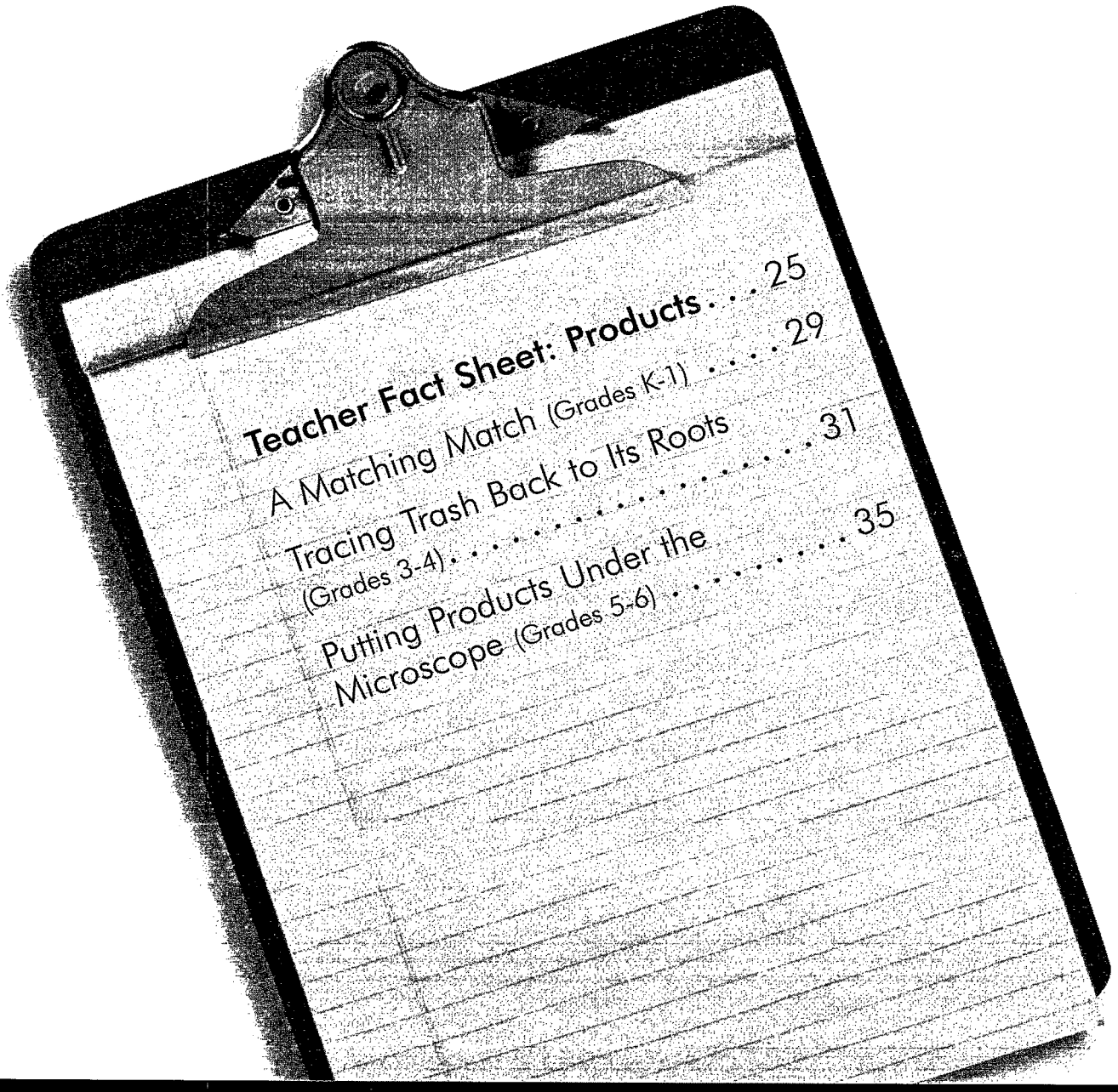
1. Have students define and describe a food web.
2. Ask students to describe the characteristics of an ecosystem.
3. Ask students to explain how several elements of an ecosystem can be harmed even if only one element is initially affected.

Enrichment

1. Repeat the exercise described in Step 6, but this time use examples of recent human actions and efforts to make a positive impact on an ecosystem. For example, through the work of biologists and naturalists, the fox is reintroduced into an ecosystem and environmental groups help Congress to pass and enforce laws to protect its habitat.
2. Present the class with a scenario that pits human activities against an ecosystem. Break the class into groups and assign different roles to the different groups. For example, one group could represent a developer that wants to fill in a wetland to build a shopping mall. Another group could represent a group of citizens of that community that want to save the wetland. Another group could represent the new workers who could benefit from jobs at the new mall. Students should be instructed to think of all the reasons why they would support or oppose the mall from their perspective and have a mini-debate about the issue.
3. Take the students on a field trip to a local park, stream, pond, or wooded area, and take an inventory of all the common birds and plants that are observed in that ecosystem. Students could learn how to use field guides and identify the species observed.
4. Give the students a list of species that have become extinct in the last 100 years and ask them to research how they became extinct (e.g., overharvesting, habitat destruction) and present the information to the class, along with a description of the species and/or a photograph. This will help the class appreciate the beauty of many of the extinct species and gain an understanding of the human activities that caused their demise.

CHAPTER 2

Products



Teacher Fact Sheet: Products . . . 25

A Matching Match (Grades K-1) 29

Tracing Trash Back to Its Roots (Grades 3-4) 31

Putting Products Under the Microscope (Grades 5-6) 35

Grade • Subject • Skills Index

Activity Name	A Matching Match	Tracing Trash Back to Its Roots	Putting Products Under the Microscope
Grade Range			
K	✔		
1	✔		
2			
3		✔	
4		✔	
5			✔
6			✔
Subjects Covered			
Math			
Science		✔	✔
Language Arts			✔
Social Studies	✔	✔	✔
Art	✔		
Health			
Skills Used*			
Communication		✔	✔
Reading			
Research			
Computation			
Observation/ Classification	✔		✔
Problem Solving		✔	✔
Motor Skills	✔		

*See Glossary of Skills for more details.

Products

How Are Products Made?

Everyone uses a variety of **products** each day—from toothbrushes to notebooks to lunch boxes to video games. Each of these products has an effect on the environment in one way or another. Sometimes merely using (or misusing) a product can affect the health of people and the environment. Some products can affect the environment through the way they are made or disposed of. For example, products made from virgin **natural resources** have different effects on the environment than those made from **recovered resources**. By understanding a product's **life cycle**—the development, use, and disposal of a product—people can make better decisions about what products to buy and how to use them wisely.

A product's life cycle generally includes design; exploration, extraction, and processing of resources (raw materials); manufacturing; distribution and use; and retirement. If a product is made from 100 percent recovered materials, exploration and extraction of virgin materials is not necessary. If a product is recycled, composted, or reused, people do not have to throw it away. By altering the product life cycle in these ways, people can save energy and resources, and therefore, prevent waste and pollution.

Key Points

- Product life cycle includes design, extraction of natural resources, manufacture, use, and disposal or recycling. If a product is made with recovered materials, raw materials do not have to be extracted from the Earth. If a product is recycled or reused, its life cycle begins anew and has less effect on the environment.
- The extraction of raw materials and the manufacture and disposal of a product can create pollution and waste and can require a great deal of energy resources.
- Durable products can be used many times, while disposable products are usually used only once.
- Product manufacturers are beginning to make more products that have environmentally preferable attributes.

The Product Life Cycle

The following sections describe each stage in the product life cycle, as well as the challenges, benefits, and emerging trends associated with each step.

Design

Product design can involve research, testing, and development. This includes development of synthetic materials, such as plastics, which derive from natural sources.

Some products are designed to be used only once (**disposable**), while others are designed to be used many times (**durable**). Engineering and material choices can determine whether a product is durable, disposable, or **recyclable**.

Over the last few decades, as people's lives have become more complicated and technology has advanced, many consumers have come to desire the convenience of disposable items over the durability of reusable ones. Also, it is sometimes easier to replace items rather than fix them. Thus, more and more items end up as trash in **landfills** or **incinerators**.

Products are often conceived and designed with a focus simply on how they will be used and with less concern about the other stages in their life cycle. In the past decade, however, consumers have begun to demand more **environmentally preferable products**—products that have fewer negative effects on human health and the environment when compared to

traditional products. Manufacturers have responded by offering products that are made from recycled-content materials, low in toxicity, and highly energy-efficient. Other products have been designed to conserve water, minimize air pollution or, through a combination of factors, have fewer negative impacts on the environment.

Exploration, Extraction, and Processing

Manufacturers must obtain the materials needed to make their products. If a manufacturer uses **recovered materials**, the company can obtain them from recycling processors or other similar sources. **Virgin resources**, however, must be mined (for metals and minerals) or harvested (for wood and other biobased materials) from the Earth. Once they are extracted, they must be processed for use in manufacturing.

The extraction of raw materials generates waste and pollution and requires a great deal of energy. In many cases, the natural resources used in manufacturing are **nonrenewable**. This means that, eventually, the natural resource will be depleted. As more and more communities offer recycling programs and people use them, manufacturers may be able to use increased recovered materials instead of virgin materials to make products.

Product Facts

- Most glass bottles and jars contain at least 30 percent recycled glass.
- Making 2,000 pounds of paper from trees requires 3,700 pounds of wood, 200 pounds of lime, 360 pounds of salt cake, 76 pounds of soda ash, 24,000 gallons of water, and 28 million BTUs of energy.
- It requires 95 percent less energy to make an aluminum can from recycled material than from the natural resource raw material, bauxite ore.
- For every 100 pounds of products made, over 3,000 pounds of waste is generated.

(Sources: Glass Packing Institute; Can Manufacturers Institute; Weyerhaeuser Company.)

Manufacturing

Whether a product is made from virgin or recovered materials, often the factories that manufacture the product are specially designed to use a consistent form of material. If a product is made in a plant designed to process virgin materials, changing to recycled feedstock might not be easy. Changing the kinds of materials used in manufacturing, such as using recycled paper instead of virgin paper, can require changes in technology and equipment and can slow down the pace of production. In the past decade, however, many manufacturing plants have begun retooling and learning to use recovered materials rather than virgin materials, and thus, the variety of recycled-content products has been growing. (See the Teacher Fact Sheet titled *Recycling* on page 73 for more information.)

Manufacturing products generates pollution and usually requires a great deal of energy resources. Using recovered materials can often save energy and reduce pollution. The manufacturing process also generates waste, but at some manufacturing plants, this waste can be reused.

Distribution and Use

People rely on various products to live in a modern society. Most people purchase and use some type of manufactured product every day because it is easier and more convenient than making the same items from scratch (for example, going to a store and buying a box or bag of rice is much simpler, and more practical, than trying to grow rice in a paddy in the backyard).

After products are manufactured, many must be packaged for transportation and distribution. Often, products are transported long distances across the nation or even internationally before people can purchase and use those items. Products often require packaging to

protect them from spoilage, damage, contamination, and tampering during transportation, storage, and sale. Sometimes packaging is necessary to inform consumers about product benefits, proper use, and other information. While some products might appear to have excessive packaging, in many cases the packaging serves several purposes, without which the products might not be available as widely or as frequently.

Packaging—when it is discarded—can create a great deal of waste. In communities where common packaging materials are not recyclable, these items must be thrown away, wasting precious resources and potential recovered materials.

Product Retirement

After use, many items or packaging are disposed of in landfills or incinerators. Others are recovered for recycling. If products are disposed of in landfills or incinerators, they can no longer provide any benefit. Emissions to air and water from these disposal methods can affect human health and the environment.

Think Globally, Buy Locally

One way consumers can help eliminate the need for excessive packaging is to buy products locally. This concept, known as bioregionalism, works on the idea that if consumers buy products made within their own communities, packaging that would otherwise be needed to protect the products during transportation and storage could be eliminated.

If products are recycled, composted, or reused, they continue to serve a purpose, either as a raw material or for the same use they were originally intended. Extending a product's life is a way to save natural resources, prevent waste reduce pollution, and conserve energy.

The more people recycle and buy recycled products, the more incentive manufacturers will have to make products with recovered content.

Additional Information Resources:

Visit the following Web sites for more information on designing and purchasing products with the environment in mind:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA Office of Solid Waste extended product responsibility site: <www.epa.gov/epaoswer/non-hw/reduce/epr/index.htm>
- U.S. EPA Office of Pollution Prevention and Toxics, Design for the Environment Program: <www.epa.gov/dfe>
- U.S. EPA Office of Pollution Prevention and Toxics, Environmentally Preferable Purchasing: <www.epa.gov/opptintr/epp>

To order the following additional documents on municipal solid waste and product life cycle, call EPA toll-free at 800 424-9346 (TDD 800 553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *WasteWise Update—Extended Product Responsibility* (EPA530-N-98-007)
- *Puzzled About Recycling's Value? Look Beyond the Bin* (EPA530-K-97-008)
- *A Collection of Solid Waste Resources*—CD-ROM

A Matching Match

social science

art

Objective

To teach students that many products come from natural resources such as animals and plants.

Subjects Covered

Natural resources
Products

Activity Description

Students will draw a line from a product to its natural source and then color the pictures.

Duration

1 hour

Materials Needed

- Copies of the *Matching Match* worksheet for each student
- Crayons

Skills Used

Observation/classification
Motor skills

Activity

Step 1: Discuss with students that everything we use is made from a natural resource, such as a plant or other resource that comes from the Earth. Some products also come from animals. Provide examples by talking about what students are wearing or items in the classroom and the sources of those items.

Step 2: Either individually or in groups, have the students use the *Matching Match* worksheets to match the different products with their natural resource.

Step 3: Encourage the students to color the pictures.

Assessment

1. Ask the students to name other items that are made from the same natural resources that are listed on the worksheet.
2. Ask students to list other plants and animals that products are made from.

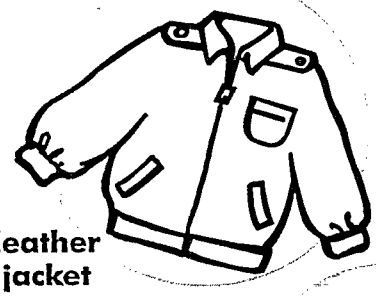
Enrichment

1. Pick a product that is made in your local community, such as paper, ice cream, or wool sweaters, and take the students on a field trip to see how it is made. Ideally, students would see how a raw material is converted into a product.

Student Handout

Matching Match

Name: _____



leather jacket

bread

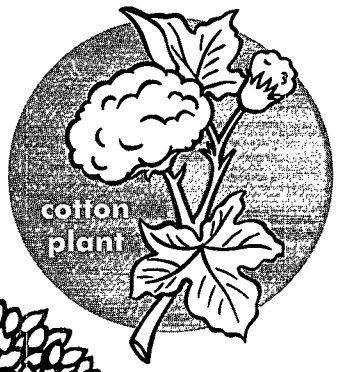
newspaper

milk

cotton t-shirt

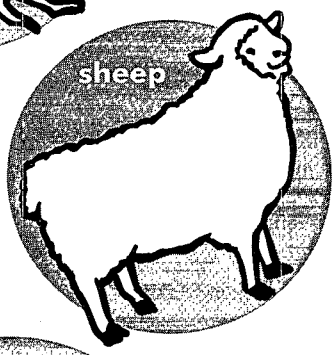
wool hat

wool sweater

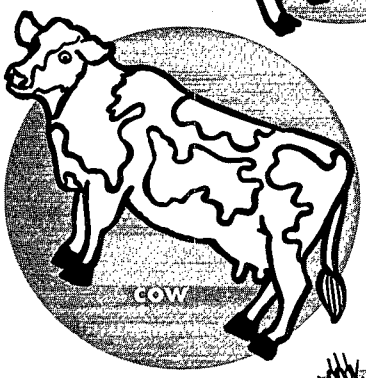


cotton plant

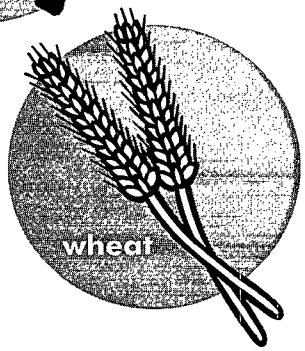
tree



sheep



cow



wheat

Tracing Trash Back to Its Roots

science

social studies

Objective

To teach students to identify the various natural resources used to produce common items that become waste.

Key Vocabulary Words

Natural resources
Renewable resources
Nonrenewable resources

Activity Description

Students will play "Trash Bingo" as a method to identify what natural resources are used to make common products.

Duration

1 hour

Materials Needed

- Copies of bingo card for each student (make copies and then cut sheets so half the students get one version of the bingo card and half get a different version).

Skills Used

Communication
Problem solving

Activity

Step 1: Review and explain the vocabulary words above. Explain that most products are made from natural resources. (Refer to the Teacher Fact Sheets titled *Natural Resources* on page 5 and *Products* on page 25 for background information.)

Step 2: List five categories of natural resources on the blackboard: animals, fossil fuels, metals, plants/trees, and sand. Discuss with students some examples of products that are made from these natural resources. Brainstorm a list of things that are made from natural resources (mostly everything!) and make another list on the blackboard. Make sure there are at least five products for each natural resource category. Encourage students to think of food and beverage items and con-

Common Products

Aluminum can	Grocery bag
Aluminum lawn chair	Hamburger
Apple core	Leather jacket
Bicycle tire	Linen pants
Bologna sandwich	Milk container
Book	Mirror
Bread	Nylon pantyhose
Cereal box	Sandwich bag
Cotton shirt	Soda bottle
Egg shells	Window
Glass bottle of juice	Wool hat

Journal Activity

Ask students to write about what natural resources mean to them. Ask them to pick a natural resource and describe why it is special or important to them.

Or

Have students write about their favorite toy or game. Have them write a history of where it came from, starting from when it was a natural resource.

tainers, household product containers, and household items (furniture, books, appliances). See suggestions in box if the list is deficient.

Step 3: Explain the rules for bingo, and hand out bingo cards.

Step 4: Select words from the students' product list (or the list of suggestions) and call out words one at a time. Instruct students to find the category or categories that each item belongs in on their bingo sheet and write the name of the product. There may be more than one natural resource for each product (for example, a pair of tennis shoes might fill three categories: plant, fossil fuel, and metal).

Step 5: The first student to fill the card wins. Use the T-R-A-S-H letters as free spaces. Be sure to check the student's bingo sheet to see if all answers are correct!

Step 6: After the bingo game, have each student circle the items that are made from renewable resources.

Assessment

1. What are natural resouces?
2. What's the difference between renewable and nonrenewable natural resources?

Enrichment

1. Additional questions include asking students what happens if we keep using more and more natural resources? How can we stop using so many natural resources? How can we use more renewable resources and less nonrenewable resources?
2. Play show and tell. Have students bring in one of their favorite "things" and tell the class where it came from, including the resources used in producing it and how it came to be in their house. Have them describe what they will do with it when it is broken, old, used up, or no longer needed.
3. Conduct a scavenger hunt. Make a list of common items found inside or outside of the classroom that are derived from animals, plants, metals/minerals, fossil fuels, or sand. Have students find 15 of 30 items and identify which category they belong in. Give the students 15 minutes to look for the items, then call them together and discuss their answers.

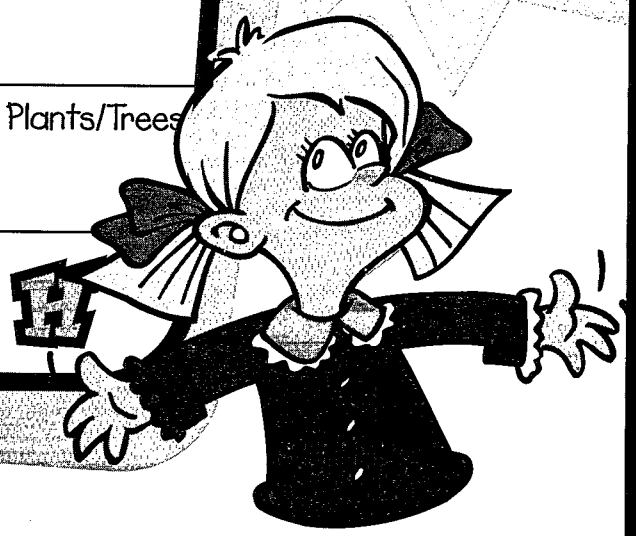
Name: _____

Trash Bingo

Animals	Fossil Fuels	Metals	S	Sand
Plants/Trees	Metals	Metals	Sand	Fossil Fuels
Fossil Fuels	R	A	Plants/Trees	Sand
T	Animals	Sand	Plants/Trees	H
Plants/Trees	Fossil Fuels	Fossil Fuels	Metals	Metals

T	Animals	Metals	Fossil Fuels	Fossil Fuels
Sand	Plants/Trees	A	Metals	Sand
Animals	Metals	Metals	Fossil Fuels	Plants/Trees
Plants/Trees	Sand	Sand	S	Plants/Trees
Fossil Fuels	R	Plants/Trees	Fossil Fuels	H

Trash Bingo



Name: _____

Putting Products Under the Microscope

Objective

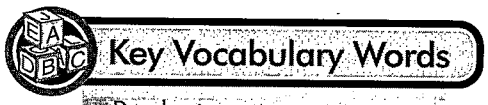
To have students evaluate a product to determine its resource use and overall impacts on the environment.

Activity Description

Students select a product manufactured in their community and discuss the raw materials and resources required to make the product.

Materials Needed

- Copies of *Product Inspector* worksheet for students.



Key Vocabulary Words

- Products
- Manufacturing process
- Raw materials
- Resources
- Ecosystems

Duration

- 30 minutes

Skills Used

- Communication
- Observation/classification
- Problem solving

Activity

Step 1: Explain that everyone uses a variety of products every day. Note that there is a manufacturing process involved in creating a new product and that any new product requires raw materials. (Refer to the Teacher Fact Sheets titled *Natural Resources* on page 5 and *Products* on page 25 for background information.)

Step 2: Have students select a product that is made in their community or state. Products might include bicycles, batteries, pens, milk, shoes, ships, plastic toys, glass bottles, or paper.

Step 3: Ask the students to draw a picture of the product. Then ask them to label all of the product's different parts and write both the raw materials used to make each part as well as the original resources used to make the raw material on the *Product Inspector* worksheet. If a student draws a car, for example, he or she would label the dashboard and note that plastic is derived from petroleum.

Step 4: Discuss whether there are more raw materials required to make the product than expected. Ask where the raw materials come from—your town, state, country, or another nation. Discuss what happens to the environment when the raw materials are extracted from the Earth or harvested. Does this process produce pollutants or harm land or ecosystems? Discuss ecosystems in your geographical area that might be affected by the removal of raw materials. How might people living in the area be affected?

Journal Activity

Ask the students to name some products they could give up for a day, a month, or longer. Ask them to describe how giving up these items would affect other people and the environment.

Step 5: Ask students to describe what happens to the product after they use it. Can it be used up or will it wear out? Can the product or its parts be reused or recycled in some way? How? Will the product or its parts decompose if buried in a landfill? What effects does disposing of this product have on the environment? Who pays for disposing of the product? Who is responsible for disposing of it?

Assessment

1. Ask students how products are created.
2. Ask students how this process impacts the environment.
3. Have students explain what happens to products after we are finished with them.
4. Ask students if they think we really need all of the products we use. Why or why not?

Enrichment

1. Contact or visit the manufacturer with your class to learn more about the process and materials used to make the product.
2. Ask students to name the different products they use during the course of a day (e.g., toothbrush, shoes). Make a list of these items on the blackboard. Then, ask students to categorize the product as essential to survival, necessary for living in today's society, or a luxury. Ask students if they are surprised how few products we really need and how many products are a luxury. Explain to students that all products create waste and that they should keep this in mind when they buy products.
3. Check books, articles, and magazines, or write to agencies or organizations to learn about the types of natural resources (e.g., wood, oil) that the United States obtains from other countries. Research whether these are renewable or nonrenewable resources. Describe what might happen if we begin to use up these resources. What can we do to conserve these resources?

Product Inspector

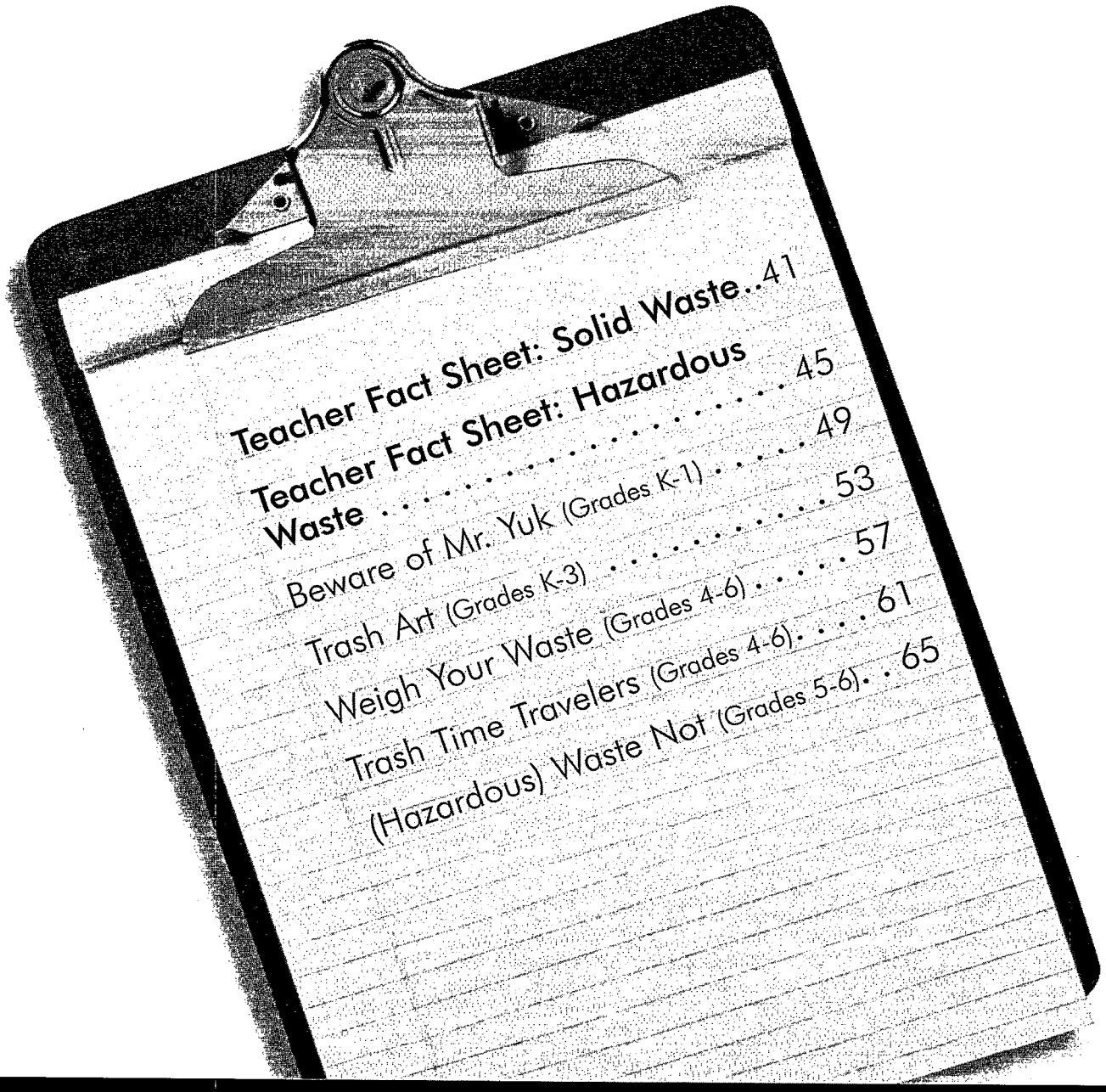
Name: _____

Name of Product: _____

Product Parts	Raw Materials Used	Original Resources

CHAPTER 3

Waste



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(Hazardous) Waste Not (Grades 5-6) . . 65

Grade • Subject • Skills Index

Activity Name	Beware of Mr. Yuk	Trash Art	Weigh Your Waste	Trash Time Travelers	(Hazardous) Waste Not
Grade Range					
K	✔	✔			
1	✔	✔			
2		✔			
3		✔			
4			✔	✔	
5			✔	✔	✔
6			✔	✔	✔
Subjects Covered					
Math			✔		
Science					✔
Language Arts				✔	
Social Studies		✔	✔	✔	✔
Art	✔	✔			
Health	✔				
Skills Used*					
Communication				✔	
Reading					✔
Research				✔	
Computation			✔		
Observation/ Classification	✔	✔	✔		✔
Problem Solving			✔		
Motor Skills	✔	✔			✔

*See Glossary of Skills for more details.

Solid Waste

What Is Solid Waste?

Young or old, everyone produces solid waste (otherwise known as trash), whether it is old newspapers, potato chip bags, shampoo bottles, cut grass, food scraps from the dinner table, old appliances, or even the kitchen sink. Each person in the United States generates about 4.5 pounds (EPA, 1998) of solid waste each day, which is often collected by a municipality and is known as **municipal solid waste**. This kind of waste primarily comes from people's homes, but it also comes from some factories, businesses, and schools.

As our population has grown, so has the number of products we use and the total amount of solid waste we generate. Consequently, the composition of garbage continues to change with more plastics, more office paper, and less glass filling up trash cans around the country. The chart below illustrates the different components of municipal solid waste.

How Do We Manage Solid Waste?

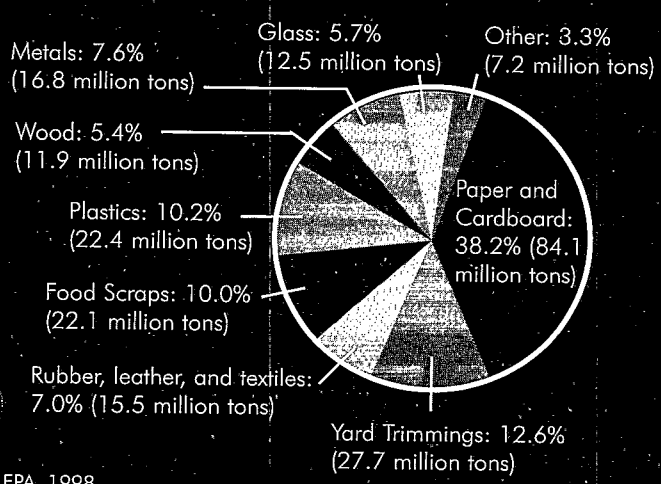
No single method can manage all our nation's garbage. The U.S. Environmental Protection Agency (EPA) recommends the use of a **"waste management hierarchy,"** which ranks methods of waste management in order of preference. Although mentioned briefly here, each method is explained in separate fact sheets. Please refer to these other fact sheets for more information regarding the benefits, challenges, trends, and opportunities of each waste management system. EPA's waste management hierarchy includes:

- *Source Reduction.* **Source reduction**, also known as **waste prevention**, is the preferred method of waste management because the best way to manage garbage is to prevent it in the first place. As the name implies, this method prevents waste at the source by decreasing consumption and reusing products. It also includes using nonhazardous substitutes to reduce the level of toxicity in the waste stream. For example, using a durable cloth lunch bag or reusing the same brown paper bag instead of a new brown paper bag each day prevents waste, or using baking soda to clean kitchen and bathroom counters rather than a chemical detergent prevents the disposal of toxins.

Key Points

- Americans generate about 4.5 pounds of garbage per person each day, which amounts to more than 220 million tons per year.
- EPA advocates a solid waste hierarchy, organizing waste management options in order of preference: source reduction, recycling and composting, and combustion and landfilling.
- Facing a variety of challenges—from rising waste generation rates and costs to closing disposal facilities—community leaders and businesses are devising ways to prevent waste and increase efficiency.

Municipal Solid Waste Composition



Source: EPA, 1998

Household Hazardous Waste

Leftover household products that contain corrosive, toxic, ignitable, or reactive ingredients are considered **"household hazardous waste."** Examples of products that could become household hazardous waste include certain cleaning products, pesticides, motor oil, oil paints, adhesives, and batteries.

Unlike municipal solid waste, special care must be taken in disposing of household hazardous waste to minimize the impact on human health and the environment.

The best ways to reduce household hazardous waste are to use up all of the products or share them with someone else until they are used up, properly recycle them, or dispose of them according to your community's solid waste regulations.

If you are unsure of what to do with these products, contact your local environmental or solid waste agency.

- *Recycling, including Composting.* If waste cannot be prevented, the next best way to reduce it is to recycle or compost it. **Recycling** refers to a series of activities where discarded materials are collected, sorted, processed, converted into raw materials, and used to make new products. **Composting** is the decomposition of organic materials such as yard trimmings and food scraps by microorganisms. The byproduct of this process is compost—a soil-like material rich in nitrogen and carbon that can be used as a plant fertilizer supplement. Both of these processes use waste as a raw material to create new and valuable products.

- *Disposal: Combustion and Landfills.* Trash that cannot be reduced, recycled, or composted must be disposed of. **Combustion** is the burning of waste in specially designed facilities. It reduces the bulk of waste and some facilities provide the added benefit of energy recovery (**"waste-to-energy" facilities**). Source reduction and recycling can remove items from the waste stream that might be difficult to burn, cause potentially harmful emissions, or make ash management problematic. **Landfills** are also major components of waste management. A landfill is a large area of land or an excavated site that receives waste. Combustion facilities and landfills are subject to environmental controls that require them to be properly maintained so there is no waste runoff that might contaminate drinking water supplies. The portion of waste requiring combustion and land disposal can be significantly reduced by examining individual contributions to garbage and by promoting the wise use and reuse of resources.

What Are the Benefits of Waste Management?

It might seem hard to believe now, but people once dumped trash out windows onto the streets, left it in local ravines or quarries, or burned it in fields and open dumps. In fact, throughout time, people have made garbage "go away" in different ways, regardless of environmental or aesthetic impacts. As one can imagine, these activities created serious sanitation problems for a community. Open dumps produced noxious odors, attracted rodents and pests that spread disease, and polluted drinking water supplies.

Federal, state, and local laws now control how solid waste is managed and disposed of. These regulations set standards for trash disposal. As a result of regulations, many communities have

Solid Waste Facts

- Each year, Americans discard more than 8 million old or broken appliances such as clothes dryers, refrigerators, and televisions.
- One third of all the garbage discarded by Americans is packaging.
- The average home may have up to 100 pounds of household hazardous waste stored throughout the house.
- Americans generate 1.6 million tons of household hazardous waste each year.

(Sources: Keep America Beautiful; Natural Resources Defense Council, 1996; EPA)

state-of-the-art landfills and combustion facilities that minimize ground- and surface-water contamination and air pollution. At the same time, they provide a safe and convenient way to remove trash from homes and neighborhoods.

Waste management can also create jobs and provide an economic boost to some cities and counties. Whether workers are collecting garbage, constructing disposal facilities, managing recycling programs, or developing new technologies, the waste management industry employs hundreds of thousands of people nationwide.

What Are the Challenges of Solid Waste Management?

Despite the improvements that have been made to solid waste landfills and combustion facilities over the years, the general public still does not want to live near a disposal facility. With varying public opinion and the Not in My Backyard (**NIMBY**) mentality, community leaders often find it difficult to find new sites for waste management facilities.

Balancing all of the management options in the solid waste hierarchy can be a major challenge. Many communities have invested resources in **source reduction** and recycling in an effort to reduce the amount of trash that must be landfilled or combusted. Yet reducing waste ultimately involves changing behaviors—purchasing environmentally friendly products when possible, and participating in recycling and composting programs.

What Are Some Emerging Trends?

Communities continue to seek ways to reduce waste. One recent trend is to charge residents for garbage collection services based on the amount of trash they throw away, known as **"Pay-As-You-Throw"** (PAYT). By paying for garbage services in the same way as electricity, water, and other utilities, residents have a direct incentive to reduce the amount of trash they generate and to recycle more.

Additional Information Resources:

Visit the following Web sites for more information on municipal solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA Office of Solid Waste site on municipal solid waste: <www.epa.gov/epaoswer/non-hw/muncpl/facts.htm>
- U.S. EPA Office of Solid Waste site on household hazardous waste: <www.epa.gov/epaoswer/non-hw/muncpl/hhwpubs.htm>

To order the following additional documents on municipal solid waste, call EPA toll-free at 800 424-9346 (TDD 800 553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *Characterization of Municipal Solid Waste in the United States*
- *Sites for our Solid Waste: A Guidebook for Public Involvement* (EPA530-SW-90-019)
- *A Collection of Solid Waste Resources*—CD-ROM

Hazardous Waste

What Is Hazardous Waste?

Many of the appliances, products, and materials used in everyday life are manufactured using processes that create **hazardous waste**. From the paint on your walls, to the components of your car, to the shingles on your house, it is likely that when these products were made, some hazardous waste was generated. Hazardous wastes are substances that exhibit one or more of the following characteristics:

- **Toxicity**—harmful or fatal when ingested or absorbed.
- **Ignitability**—creates fire under certain conditions or spontaneously combusts.
- **Corrosivity**—contains acids or bases that can corrode metal.
- **Reactivity**—is unstable under "normal" conditions and can cause explosions, toxic fumes, or vapors when mixed with water.

Hazardous waste is created by a variety of different industries, such as petroleum refining and pesticide, chemical, ink, paint, and paper manufacturing. It also is created by the activities of certain smaller businesses found in many communities, such as dry cleaners, vehicle maintenance shops, vocational schools, and photoprocessing stores. In addition, hazardous waste is created when businesses or facilities dispose of certain unused products.

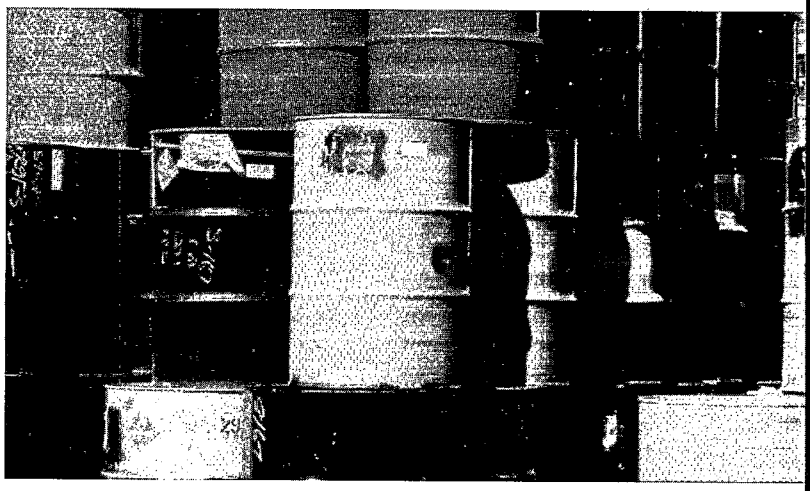
Hazardous waste is an inevitable product of a thriving industrial society. It is important to be aware that the choices consumers make when selecting products, services, and materials have hidden environmental effects. Consumers also should realize that the management of hazardous waste is regulated by law and that facilities that produce, transport, or dispose of it must follow very specific rules to minimize environmental and human health problems. The primary law that governs the proper management of hazardous waste is known as the **Resource Conversation and Recovery Act (RCRA)**.

Key Points

- Hazardous waste can be produced in the manufacturing process of many common products people use every day, as well as many common services.
- To protect human health and the environment, hazardous waste is regulated from the time it is produced to the time it is disposed of.

How Do We Manage Hazardous Waste?

The RCRA regulations cover all aspects of hazardous waste—from the time it is generated at a factory or plant until the time it is discarded. This is known as "cradle to grave." This regulatory system includes many detailed rules that require hazardous waste to be tracked as it



"Hazardous Waste" Versus "Household Hazardous Waste"

"Hazardous waste" is regulated by EPA. Businesses, institutions, or other facilities (sometimes including schools) that generate it must comply with certain rules regarding generation, management, transportation, and disposal.

When individuals dispose of household products from their home that contain hazardous ingredients, such as pesticides, cleaners, batteries, or used oil, they create what is known as **household hazardous waste**. Individuals usually produce much less hazardous waste than businesses and other facilities, and they are not regulated by EPA. Even so, many communities require or prefer that household hazardous waste is handled separately from the regular garbage to prevent any potential risks to the environment or human health.

When disposing of household hazardous waste from your home, remember the following:

- Sharing leftover household products is a great way for people to use all of a product and avoid disposal. If you cannot share or donate leftover products, check with your local environmental or solid waste agency to see if your community has a facility that collects household hazardous wastes year-round or offers opportunities for exchanging products with other residents.
- If your community doesn't have a collection program for household hazardous waste, contact your local environmental or solid waste agency to see if there are any designated days in your area for collecting these materials. On such days, qualified professionals collect household hazardous waste at a central location to ensure safe management and disposal.
- If your community has neither a permanent collection site nor a special collection day, you might be able to drop off certain products, such as batteries, paint, or automotive supplies, at local businesses for recycling or proper disposal. Call your local environmental or solid waste agency or Chamber of Commerce for information.
- Some communities allow disposal of household hazardous waste in trash as a last resort. Call your local environmental or solid waste agency for instructions on proper disposal. Be sure to read the product label for disposal directions to reduce the risk of products exploding, igniting, leaking, mixing with other chemicals, or posing other hazards on the way to a disposal facility. Even empty containers of household hazardous waste can pose hazards due to residue.

moves from place to place; one of the rules requires the use of a tracking paper known as a "manifest." This paper must travel with the waste wherever it goes (e.g., wherever it is stored, shipped, recycled, or disposed of).

Depending on how much waste a facility generates, it is regulated differently; bigger facilities that produce a large amount of hazardous waste each month have more rules than those that produce a small amount of waste.

After a company or factory generates hazardous waste, the waste must be packaged and labeled in special containers, and it must be transported by a regulated hazardous transportation company in special packages with specific labels. These trucks often can be identified on the highway by multicolored placards and symbols that indicate the type of hazardous waste they carry. The Department of Transportation is responsible for regulating these trucks.

Hazardous waste is usually transported to a facility that treats, stores, and/or disposes of it. Most hazardous waste must be specially treated with certain processes to alter its hazardous composition before it can safely be recovered, reused, or disposed of. Sometimes waste is stored temporarily in a regulated unit. When the waste is

ultimately disposed of, it is transported either to a landfill or special combustion facility (see Teacher Fact Sheets titled *Landfills* on page 155 and *Combustion* on page 159). Combustion facilities must take special precautions to prevent air pollution, and they must ensure that only appropriate wastes are burned.

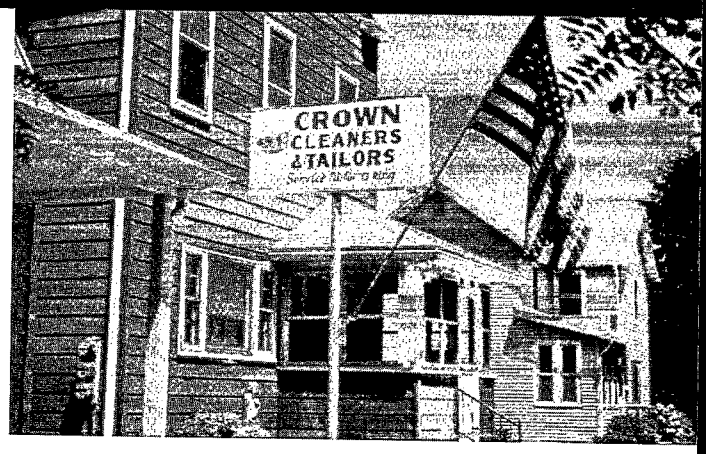
Sometimes hazardous waste is transported to a facility that recycles hazardous waste. Certain hazardous wastes can be recycled and used again. For example, many solvents can be recovered, some metals can be reclaimed, and certain fuels can be re-blended. Hazardous waste recycling is regulated under RCRA to ensure the protection of human health and the environment.

To keep track of all of the facilities that treat, store, or dispose of hazardous waste and ensure that they follow the rules, EPA and many states have a permitting system. Each company must obtain a permit, which tells companies what they are allowed and not allowed to do. Inspectors check these facilities regularly by reviewing company records, observing operating procedures, and sometimes collecting hazardous waste samples. For further tracking purposes, EPA also requires all companies that generate hazardous waste to register and obtain an EPA identification number.

Hazardous Waste Facts

- In 1997, companies produced nearly 40.7 million tons of hazardous waste.
- More than 20,000 large facilities generated hazardous waste in 1997.
- Many hazardous wastes can be generated in schools, such as solvents from cleaning, chemicals from chemistry labs, fluorescent light bulbs, computer monitors, and chemical residues from woodshops.

(Source: EPA, 1997, 2000)



What Are the Benefits of Hazardous Waste Management?

Before RCRA took effect in 1970, companies could—and did—dispose of hazardous waste in rivers, streams, and other inappropriate places. By enforcing strict rules about the way waste is handled, EPA and other agencies can better control the effects of hazardous waste on the environment and human health. These controls, while not always perfect, allow the industrial production on which we all depend to continue in as safe a manner as possible.

In addition, EPA has made waste minimization practices and pollution prevention activities key requirements for companies that produce hazardous waste. Any company that creates a certain amount of hazardous waste each month must sign a statement indicating that it has a program in place to reduce both the amount and toxicity of its hazardous waste. These companies also must indicate that they have chosen a method of hazardous waste treatment, storage, or disposal that minimizes the present and future threat to human health and the environment.

It can be difficult for individuals to identify companies that have taken substantial measures to minimize hazardous waste and prevent pollution, and thus, it is not always possible to lend support for these activities by patronizing those companies. When information of this sort is available, however, consumer demand can make a difference.

What Are the Challenges of Hazardous Waste Management?

Just as people and communities generally do not want municipal solid waste facilities in their neighborhoods, they often do not want hazardous waste facilities near their homes and schools (the NIMBY mentality). When new hazardous waste generation or treatment facilities are sited near communities, the public can become involved in the process, but it can be a challenge for companies and communities to achieve mutually acceptable solutions.

The RCRA regulations allow the public to have an opportunity to participate in decisions about hazardous waste management. Through public meetings and other open forums, people can express their concerns about a new facility.

Additional Information Resources:

Visit the following Web sites for more information on hazardous waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA Office of Solid Waste site on hazardous waste: <www.epa.gov/epaoswer/osw/hazwaste.htm>

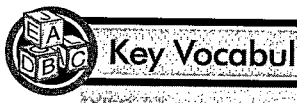
To order the following additional documents on hazardous waste, call EPA toll-free at 800 424-9346 (TDD 800 553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *The RCRA Public Participation Manual* (EPA530-R-96-007)
- *HAZ-ED: Classroom Activities for Understanding Hazardous Waste* (EPA540-K-95-005)
- *RCRA Orientation Manual: 1998 Edition* (EPA530-R-98-004)
- *RCRA: Reducing Risk From Waste* (EPA530-K-97-004)

Beware of Mr. Yuk!

Objective

To teach students to recognize the "Mr. Yuk" symbol; to help students understand that this symbol designates hazardous household products that should not be handled by children without adult supervision and without reading labels properly.



Key Vocabulary Words

- Product
- Poison
- Danger

Activity Description

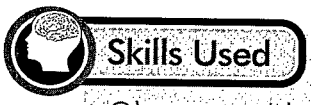
Students will identify Mr. Yuk stickers in the hidden picture and color them in bright green to signify hazard/poison.

Duration

- 30 minutes

Materials Needed

- One copy of the *Beware of Mr. Yuk* worksheet per student
- One red or green crayon for each student (Preferably from the fluorescent color box)



Skills Used

- Observation/classification
- Motor skills

Activity

Step 1: Put an enlarged picture of Mr. Yuk on the blackboard and ask students if they've seen it before. Elicit from students how they would describe Mr. Yuk.

Step 2: Tell the students they will be given a drawing of a house. In the picture are many products commonly found in homes, and they will have to find the ones with a Mr. Yuk face on them. Explain that if they were to find a real product in their real home with a Mr. Yuk face on it, they should not touch it; they should tell an adult about it. Ask them where Mr. Yuk products are sometimes located in a home (e.g., kitchen, bathroom, garage).

Step 3: Distribute crayons and worksheets to students and ask them to color only the Mr. Yuk stickers on the products they see. Students can work individually or in groups.

Step 4: After coloring the Mr. Yuk stickers, students can color the entire scene.

Mr. Yuk Stickers

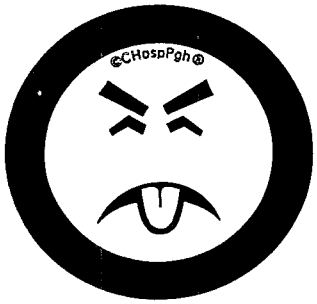
Teachers who wish to promote the use of Mr. Yuk stickers at home could consider sending a note to parents indicating where stickers can be obtained. Most local poison control centers have Mr. Yuk stickers available.

Assessment

1. Collect the *Beware of Mr. Yuk* worksheets and assess whether students correctly identified products labeled with Mr. Yuk.
2. Ask students what they would do if they found a Mr. Yuk sticker in their homes.
3. Ask students why certain products get labeled with Mr. Yuk stickers.

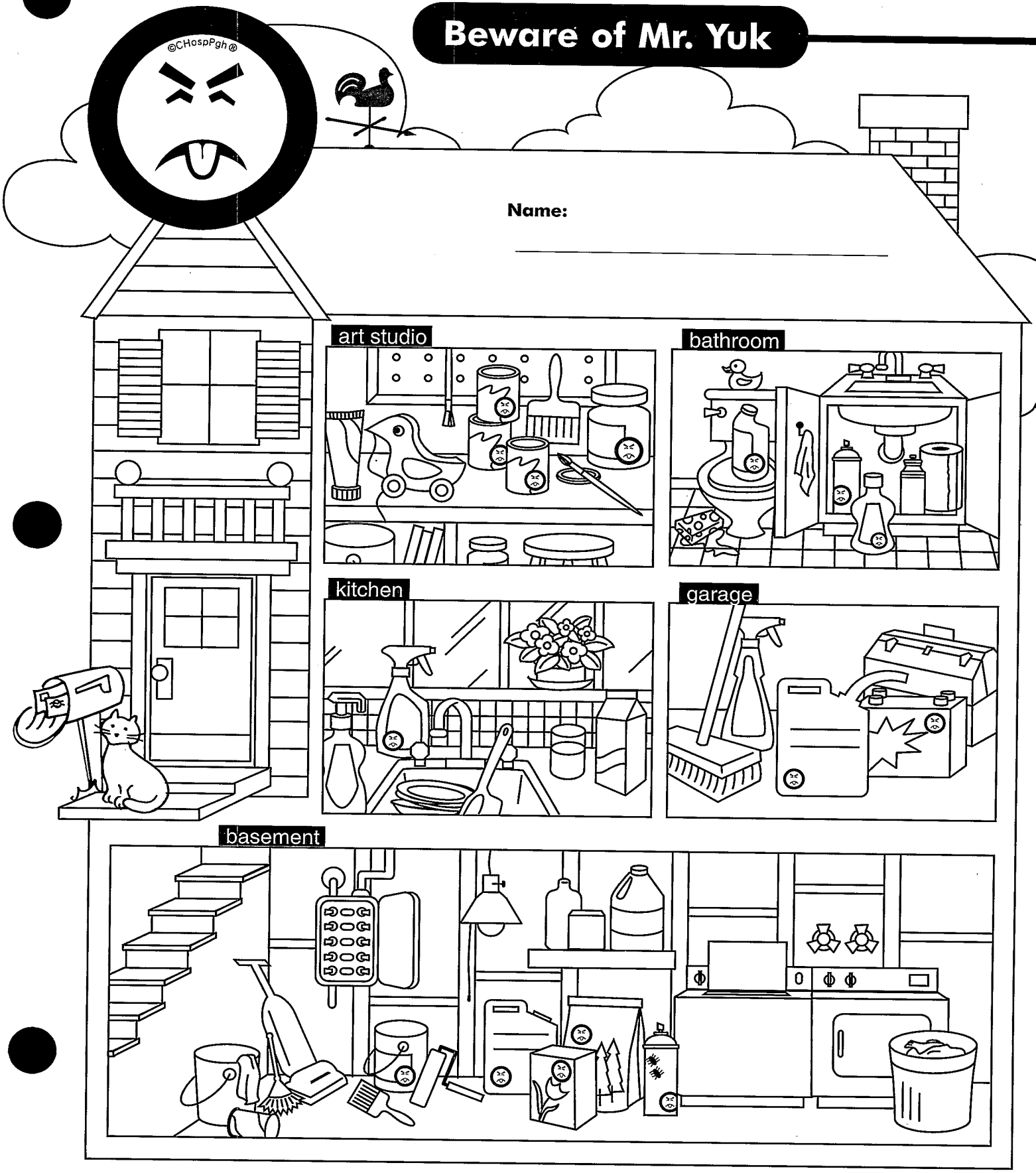
Enrichment

1. Conduct a role-playing game by putting a Mr. Yuk sticker on an empty product container and asking students to pretend they come upon it in their homes. Have one or more students pretend that they are parents and are telling the "kids" about the Mr. Yuk sticker and its importance.
2. Ask students to draw places in their homes where Mr. Yuk products might be found (kitchen, bathroom, garage, etc.)



Mr. Yuk is reprinted with permission, Children's Hospital of Pittsburgh, Pittsburgh, PA.

Beware of Mr. Yuk



Trash Art

social studies

art

Objective

To encourage students to think about what kinds of materials they throw away.

Activity Description

Students will create a trash mural from collected pieces of home garbage and images of disposable items from magazines.

Materials Needed

- One copy of Parents' Note for each student
- One tarp or drop cloth
- 10 to 12 magazines (with lots of everyday product advertisements)
- "Clean" garbage (brought in by students)
- Art supplies (enough for class):
  - — Three to four sheets of colored construction paper per student
  - — Glue
  - — Tape
  - — Scissors
  - — Markers or crayons
  - — Glitter

Key Vocabulary Words

Waste
Product

Duration

1 hour

Skills Used

Observation/classification
Motor skills

Activity

Step 1: Photocopy and send students home with the Parents' Note, which asks them to help the students collect two pieces of "clean" garbage for class the next day.

Step 2: Lead students in a discussion of what garbage is and where it comes from. Ask them if they know how to identify garbage.

Step 3: Lay a tarp on the floor and have the students sit in a circle around it. Ask them to spread out their pieces of garbage on the tarp. Go around the room and ask each student to describe what kind of garbage they brought in. Explore how students knew the item was garbage and what its purpose was before it became garbage. Encourage the students to compare and contrast the shapes, colors, and sizes of the garbage on the tarp.

Step 4: Divide the class into pairs and distribute a magazine and scissors to each pair

(teachers should use their judgement about the use of scissors for younger students). Tell the students to look for pictures of objects or products that are only used once and then thrown away. Ask the students to cut out as many of these objects as they can. Go around the room to discuss what pictures were chosen and why.

Step 5: Distribute the rest of the art supplies. The art exercise for this activity can be conducted in many different ways; below are a few age-specific suggestions:

For younger students:

- Instruct students to use their magazine pictures and trash objects to make a collage by gluing them onto the construction paper. Help all of the students tape their construction paper up on the classroom wall to form a colorful trash mural.
- Have students organize their trash in terms of color or size. Help students decide where each piece of garbage should go on the mural so that alike items are grouped together.

For older students:

- Have students make a trash rainbow by organizing the trash into rainbow colors. Students could draw the outline of the rainbow on the paper first, then paste their trash in the appropriate color band on the mural.
- Have students design a 3-D trash sculpture. Ask them to think about the color and shape of each trash item before gluing it onto the sculpture.
- Have students organize the trash by the purpose it had during its useful life. For example: was it a product or packaging for a product? A cleaning product, food product, or hair product? Ask students to write down category names on the mural and then paste their trash in the appropriate spot.

Assessment

1. Ask students to name three different items that they or their family members often throw away.
2. Have the students guess how many pieces of trash are on the class trash mural. Discuss with students that the mural is just a small amount of what gets thrown away every day in the world.
3. Ask students what purpose the trash served during its useful life. Ask them what it was before it became trash.

Enrichment

1. Conduct a followup activity on what happens to garbage after it's thrown in the trash can. This resource offers the following activities: Luscious Layered Landfill on page 163 (for younger students) or A Landfill Is No Dump on page 167 (for older students).
2. Take a field trip to a waste disposal site (a landfill or incinerator) to find out where waste goes. See the Teacher Fact Sheets titled *Landfills* on pg. 155 and *Combustion* on pg. 159 for background information.
3. For grades 2-3, enrich the activities by doing the following:

- After students have brought in pieces of trash, ask them to separate the items into the following categories: paper, metal, food, glass, plastic. Discuss whether these items need to be thrown away or whether they can be reused or recycled.
- Have students determine how much of each category of trash items they have collected. Draw a trash can on the chalkboard and have students come up and use a different color piece of chalk to make hash marks (in the "trash can") for each type of trash item collected.

Parents' Note

Dear Parent,

Tomorrow we are undertaking an environmental education activity to learn more about how much garbage we create and what we do with it. I have asked each student to bring in two pieces of "clean" garbage for our trash mural. In the interest of safety and sanitation, I would appreciate your assistance in helping your child pick out two garbage items that are manageable in size and "clean" (no glass, jagged metal, food, or wet items). Good examples of "clean" garbage include: a cereal box, empty soda can, paper, plastic bag, wrapping, packaging, plastic juice bottle, etc.

Thanks for your help!

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Thanks for your help!

Weigh Your Waste!

math

social studies

Objective

To increase students' awareness of the amount of waste they generate and the implication of that waste.

Key Vocabulary Words

Waste
Per capita

Activity Description

Students will collect, weigh, record, and analyze the amount of trash they generate in the course of a week.

Duration

1 to 2 hours, with periodic discussions over the course of a week

Materials Needed

- One trash bag per student
- One twist tie garbage bag fastener for each student
- One 3- by 5-inch note card per student
- One plastic tarp
- One set of gloves per student
- One scale
- One copy of *My Trash Journal* for each student
- Clear tape

Skills Used

Computation
Observation/classification
Problem solving

Activity

Step 1: Photocopy and distribute copies of the *My Trash Journal* worksheet to each student. Refer to the Teacher Fact Sheet titled *Wastes* for background information.

Step 2: Distribute one garbage bag, one twist tie, and one note card to each student. Tell students to take the trash bag to classes for 1 week (5 days), using it to collect all of the "dry" garbage they throw away at school. Instruct students to include all of their used containers, paper waste, and packaging, but **not** to include food waste or any other type of "wet" trash that might decompose or be unsanitary. For safety reasons, instruct students not to collect glass items either.

Step 3: Have the students put their names on the note cards and tape them to the twist ties (or use a hole-punch). Then have students use the twist ties to close their garbage bags. Explain that at the end of each day, students will bring their garbage bags back to the classroom and store them overnight in a designated spot (show them the location). The name tags will allow them to pick out their trash bag the next morning.

Step 4: At the end of the week, ask the students to predict how much their individual piles weigh. Ask them to predict how much the total pile of garbage for the whole class would weigh. Write some of these predictions on the board.

Journal Activity

Have students write a commercial "jingle" asking people to reduce the amount of waste they generate.

Step 5: Bring in a tarp and spread it on the floor. Have each student spread the contents of his or her personal trash bag on the tarp. Have the students put on gloves and sort their individual piles of garbage into as many categories as possible: plastics, aluminum, paper, steel, and mixed materials (those that fit into more than one category). Have them record the contents of their garbage piles using the *My Trash Journal* worksheet.

Step 6: Have students weigh their individual piles of garbage on a scale and record the amounts on the chalkboard.

Step 7: Ask a student to total the weights of each individual pile of garbage and put this number on the chalkboard. Determine the average weight of trash generated per student per day. Compare these weights to the students' predictions.

Step 8: Write the national average of waste generation on the board: 4.3 pounds per person per day.

Ask the students to determine the following:

- How much waste did the class generate per day on average? Is this higher or lower than the national average?
- If each person in your community (population_____) throws away ___ pounds (use the students' average calculated above) of garbage each day, how many total pounds of garbage are thrown away each day in your community?
- How many tons is this? (To help children grasp the concept of a ton [2,000 pounds] you might want to ask them how many tons some familiar objects weigh, for example, an average 4-door compact car weighs about a ton.)

Assessment

1. Ask the students why they think they generate so much trash. Is it more or less than they anticipated?
2. Ask the students if they were surprised at how much trash they generated. Where does all of this waste go every day? (See the Teacher Fact Sheet titled *Landfills* on page 155 for background information.) Why should we care how much we throw away?
3. Ask students to look at their waste generation charts and think of ways they could have reduced the amount of garbage generated this week. (Could any items have been recycled or reused? What about using less in the first place? For example, bringing a reusable cloth lunch bag instead of a paper lunch bag each day.) Refer to the Teacher Fact Sheets titled *Recycling* on page 73, *Source Reduction* on page 133, and *Composting* on page 109 for background information.

Enrichment

1. Have students identify the categories of materials they generally throw away or recycle. Make a list of common items on the board (recyclable and nonrecyclable). Ask students how much less waste they would have generated if they recycled instead of discarded all of the recyclable materials they used this week.
2. Have a student contact your state or municipal solid waste manager to find out about your community's trash generation rate. How does it compare to other communities in your county or state? Discuss the results and reasons behind them with your students.
3. Have students record the amount of waste their families generate at home in 1 week (a note to parents explaining the assignment might help). Suggest students weigh each bag of trash generated on a bathroom scale.

Students should keep a log of these weights. At the end of the week, have students compare their data with classmates.

4. Either in class or as a homework assignment, ask the students to create graphs and charts of their data from class and home waste generation. The graphs might include:

   - A pie chart of the number of pounds for each material measured for each individual.
   - After pairing up with a partner and comparing notes, a bar graph of the number of pounds of each material for the two students.
   - A bar graph and/or pie chart showing the amount of total materials collected that were recyclable versus not recyclable in your community.

   Discuss with students which materials were generated more than others and whether more recyclable or nonrecyclable materials were generated.

5. Take a field trip to a landfill or combustion facility so students can see what happens to their trash.

6. Partner with a local business to calculate how much waste the company generates in a given day by conducting an audit of the paper waste (or other dry waste) generated.

7. Get permission for your class to sort through the school dumpster on a given day (with appropriate safety equipment such as gloves and goggles) to weigh its amount and determine how much useful or recyclable material is thrown out.

My Trash Journal

Name: _____

What Did I Throw Away?	What Material Category Does it Belong In? *(Paper, Glass, Aluminum, Steel, Plastic)*	My Ideas for Using Less, Reusing, or Recycling this Item
Example: 1 soda bottle	Glass	I could recycle this in bins outside my school.
Example: 5 lunch bags	Paper	I could use a cloth lunch bag each day instead of using paper.

Total weight of my garbage for one week = [calculated in class]

Weight of recyclables = [calculated in class]	**Weight of nonrecyclables =** [calculated in class]

Total weight of my garbage per day = [calculated in class]

Total weight of class garbage for one week = [calculated in class]

Average amount of waste generated per student per day in our class = [calculated in class]

Trash Time Travelers

language arts

social studies

Objective

To teach students how lifestyles change over time and how these changes alter the production and management of waste.

Activity Description

Students will interview adults, either at home or in the community, to find out what people considered trash years ago and how that trash was handled.

Materials Needed

- One copy of the *Rubbish Reporter* worksheet per student
- Brightly colored markers (one per student)
- One ball of string or twine
- One hole-punch
- One roll of masking tape

Key Vocabulary Words

Landfill
Recycle
Reuse
Combustion

(this list will vary for each student's interview)

Duration

2 hours over two class periods

Skills Used

Communication
Research

Activity

Step 1: Photocopy and distribute the *Rubbish Reporter* worksheets to each student. Conduct an introductory discussion touching on the following topics (refer to the Teacher Fact Sheet titled *Solid Waste* on pg. 41 for background information):

- Discuss what the common components of our trash are today—list them on the board.
- Ask students to think about how this list might differ from the trash list of a settler in colonial times, a farmer during the Great Depression, or a grandparent who lived through World War II.
- Discuss how trash is disposed of today and ask students how they think people of other time periods disposed of trash.

Step 2: Inform students that they are now "Rubbish Reporters." Their assignment is to write a story about how different lifestyles in different historical periods affected the generation and handling of trash.

Step 3: Have students take the *Rubbish Reporter* worksheet home and use it to interview at least two elderly family or community members. Give students 2 or 3 days to complete this assignment.

Step 4: Have students bring in their completed *Rubbish Reporter* worksheets and pick one of their interviewees to focus on. As an in-class assignment, have the students use their completed worksheets to write a short paragraph or "article" about what their interviewee thought of "trash," how they disposed of trash, and how those ideas and practices might differ from ours today. Instruct students to mark

Journal Activity

Ask students to pretend that they are each of the following characters: a pilgrim living in the 1500s, a professional (business person) living in the city today, and a grizzly bear living today in Yellowstone National Park. Have students write about what kinds of trash they generate as each of these characters. Ask them which character they think is most wasteful and why.

(in the left-hand corner of the page) the year (or years) that their interviewee remembered or referred to during the interview.

Step 5: Go around the room and have each student stand up and read his or her article out loud to the class. Discuss the issues, such as time period, geographical location, trash disposal, and recycling, that are raised in each article.

Step 6: After discussing each article, have the students determine its one aspect of trash disposal or management that is most unique. (*For example, someone may have saved all metal for recycling during WW II or burned his/her own trash on a farm each day, etc.*) Have the student write this one aspect with a colored marker at the top of his/her article.

Step 7: Collect all of the articles and spread them out on the floor. Have the students help you organize them in a time line according to the years marked in the upper left-hand corner of the pages.

Step 8: Using the hole-punch, put holes in the tops of each article and connect them using the string. Hang your "Trash Time line" somewhere in the classroom or school.

Assessment

1. Collect all of the students' *Rubbish Reporter* worksheets and articles and evaluate them for completeness, comprehension, and content.
2. Ask students to offer an explanation of why trash and its management differs for each generation. Ask them to predict what trash will be like in the future and what people will do with trash 100 years from now.
3. Have students list four ways in which trash management in the past differs from trash management today.

Enrichment

1. If there are one or two very interesting or unique trash stories that students bring in, ask those interviewees to come in and speak to the class more extensively about their recollections. Have students prepare questions in advance to ask the guest speaker.
2. Using the different time periods or locations that surface during the students' interviews, pick one or two for an in-depth history and social studies lesson. Have students explore the setting of the time period, learn about the political and social events of that time, and investigate how these might have affected trash and its disposal.

The Rubbish Reporter

Name: _____

General Assignment: Ask your interviewee to pick a time in his/her past that is easy to recall in detail. Ask the interviewee to remember what he/she considered trash at that time (what was thrown out), how that trash was disposed of, where it was disposed of, and how all of these characteristics compare with today's ideas about trash and methods for handling trash.

Rubbish Reporter's name:

_____

Interviewee's name:

_____

What time period(s) does your interview cover?

_____

What geographical location?

_____

Interview Questions

1. What time period are you going to talk about? How old were you then? What was your occupation (if you were old enough)?

_____

2. What were the most important political and social events during the time period you are remembering?

_____

3. What did you consider trash when you were younger? What kinds of things did you throw out?

_____

4. How was your trash handled? Was it picked up, sent to a landfill, burned? Who provided this service?

_____

Student Handout

Interview Questions (continued)

5. Did you reuse or repair items? What kinds of items did you reuse? Did you recycle? What did you recycle? What were recyclables made into or used for?

6. Name some products that you use today that were not available to you then.

7. What were many of your products (such as toys, food containers, or appliances) made of during this time period? Did you have a lot of plastic products? Glass? Metal? How were they packaged?

8. What was your attitude toward trash then? Has it changed now?

Rubbish Reporter: Can you think of any more questions to ask?

9. Do you think we are more wasteful as a society today?

(Hazardous) Waste Not

Social Studies

Science

Objective

To show students what could happen to ground water if hazardous waste were not regulated.

Activity Description

Students will create an aquifer and demonstrate how hazardous waste could seep into ground water.

Materials Needed

- Clear plastic cup for each student
- *What's Going on Underground* diagram for each student
- Molding clay (enough for each student to have a ½-inch by ½-inch square)
- One-quart container filled with sand
- Container of small pebbles (enough for a ½ cup for each student)
- Bucket of water and ladle
- Red food coloring

Key Vocabulary Words

Aquifer
Hazardous waste
Byproduct
Regulation
Ground water
Saturated zone
Porous
Water table
Surface water

Duration

1 hour

Skills Used

Reading
Observation/classification
Motor skills

Activity

Step 1: Discuss with the class how ground water is a major source of drinking water for as much as half of the U.S. population. Provide each student with the *What's Going on Underground* diagram and discuss how ground water forms, exists, and can be extracted. Review the vocabulary words and definitions provided on the diagram. Explain that it would be very easy to contaminate ground water if hazardous waste were simply dumped on the ground and absorbed by the soil. Define and discuss hazardous waste. (Refer to the Teacher Fact Sheet titled *Hazardous Waste* on pg. 45 for background information.)

Step 2: Place the containers of pebbles, sand, and bucket of water with the ladle on a table in the classroom where each student can access them.

Step 3: Pass out a plastic cup to each student. Ask the students to fill their cups half full

RCRA and Hazardous Waste

In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA) to protect human health and the environment from the potential hazards of waste disposal. RCRA establishes a regulatory system for managing hazardous waste from generation until ultimate disposal ("cradle to grave").

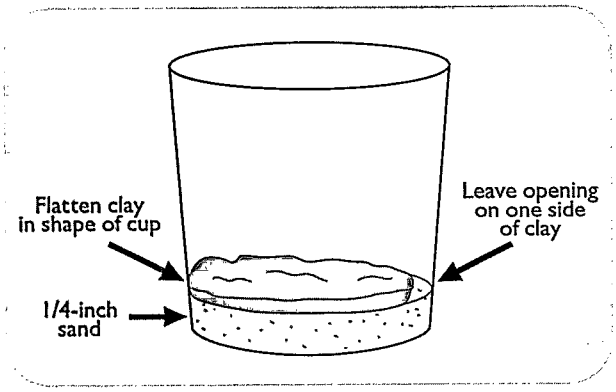
Journal Activity

Ask students to prepare questions and answers representing an interview with an animal, tree, flower, or other member of nature. Students should think about how elements in nature would "feel" about hazardous waste contamination in the environment. Have them pretend they are reporters trying to discover how hazardous waste can affect the natural environment.

of small pebbles. In addition, give each student a ½-inch by ½-inch piece of the molding clay. Ask the students to dump the pebbles on their desk and keep them there temporarily.

Step 4: Ask each student to go to the sand container and scoop enough so that there is about 1/4-inch on the bottom of their cups. After they add the sand, ask them to ladle just enough water into the cup so that it is absorbed by the sand. Discuss how the water is still in the cup, but that it is being stored in the "ground."

Step 5: Have each student flatten their clay in the shape of the cup bottom and then place it over the sand. Fasten the clay to one side of the cup, but leave an opening on the other side.



Step 6: Ask each student to place their pile of pebbles into the cup, on top of the clay. They can place the pebbles so that they lay flat or form hills and valleys.

Step 7: Ask the students to add a ladle full of water to their "aquifers." Students that formed hills and valleys with their pebbles will see that they have surface water in addition to ground water, depending on how much water they added to their cups. Discuss how both surface and ground water can be sources of drinking water and that some parts of the ground are more porous than others (e.g., water slips more easily through the pebbles than the clay).

Ground Water Contamination

Ground water contamination can occur when liquids (usually rainwater) move through waste disposal sites, carrying pollutants with them, and into the ground water. RCRA regulations require ground water monitoring, which detects early signs of contaminants leaching from hazardous waste facilities.

Step 8: Tell the students to imagine that there is a factory that produces "widgets" near their aquifer. In the course of producing widgets, the factory produces a hazardous waste byproduct. Ask students to imagine that hazardous waste regulations do not exist and that the factory is allowed to dump its hazardous waste on the ground outside, which is also an aquifer.

Step 9: Pass the food coloring around the room so that each student can add a few drops to their aquifers. Explain that the food coloring represents hazardous waste that is being dumped illegally. Ask the students to watch the path of the food coloring.

Step 10: Discuss how easy it is to pollute and contaminate the ground water. Explain that this is why the government has created very detailed laws about how companies must deal with their hazardous waste.

Assessment

1. Ask students to explain how activities above the ground can affect the water underground.
2. Have students tell you why hazardous waste is regulated.

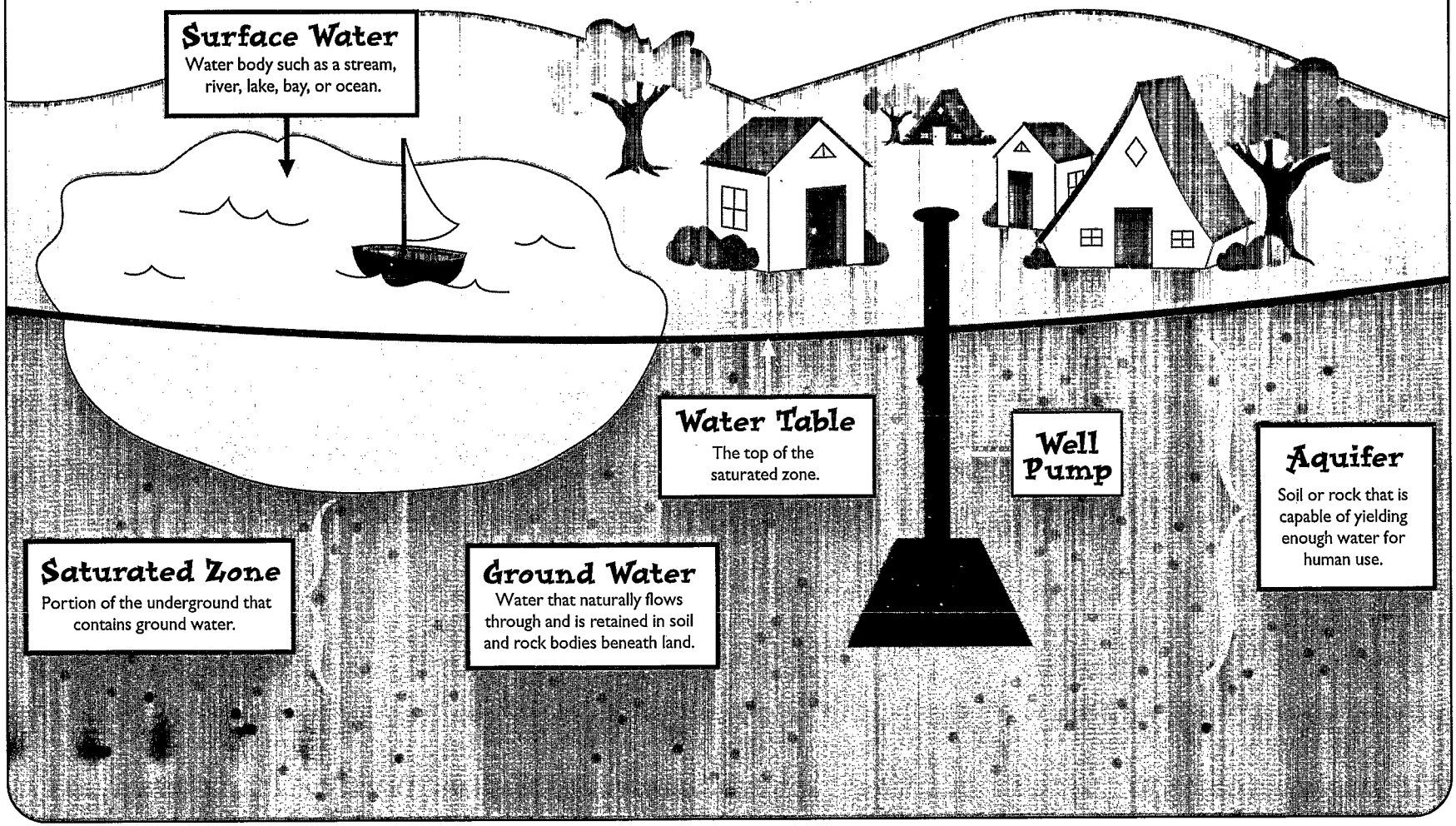
Enrichment

1. Draw a map of your community or region including all the waterways. Add a local source of potential hazardous waste pollution to the map and trace the path its waste would take if it were not regulated. (See the sidebar for a list of hazardous waste generators.) Discuss how streams and creeks feed into larger bodies of water and how pollution at a small, local stream can result in pollution in rivers, lakes, bays, and/or oceans. This activity can be used to teach or review the concept of "bird's-eye" view, the different types of maps, and the use of legends and symbols.
2. Using papier maché or modeling clay and water-based paints, develop a relief map of the community or region including all waterways. To physically show how hazardous waste can travel through all waterways, put a few drops of food coloring on one end of the map. Tilt the structure, if necessary, and watch the food coloring travel.
3. Elicit what would happen to our waterways if they became contaminated by hazardous waste. How would people and ecosystems be affected?

Local Hazardous Waste Generators

- Dry cleaners
- Print shops
- Vehicle maintenance shops
- Photoprocessing stores

What's Going On Underground?

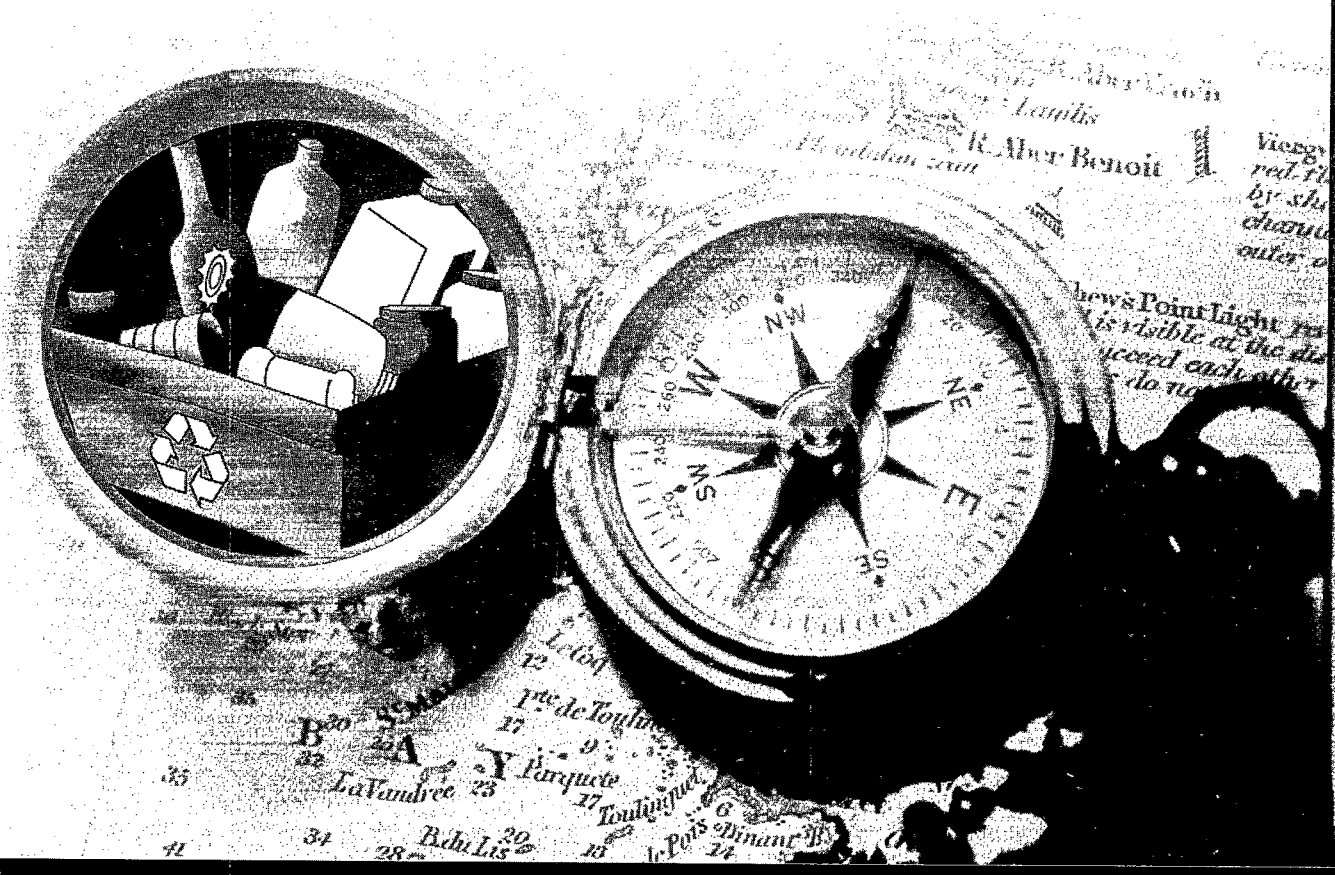


UNIT 2

Methods of Handling Waste

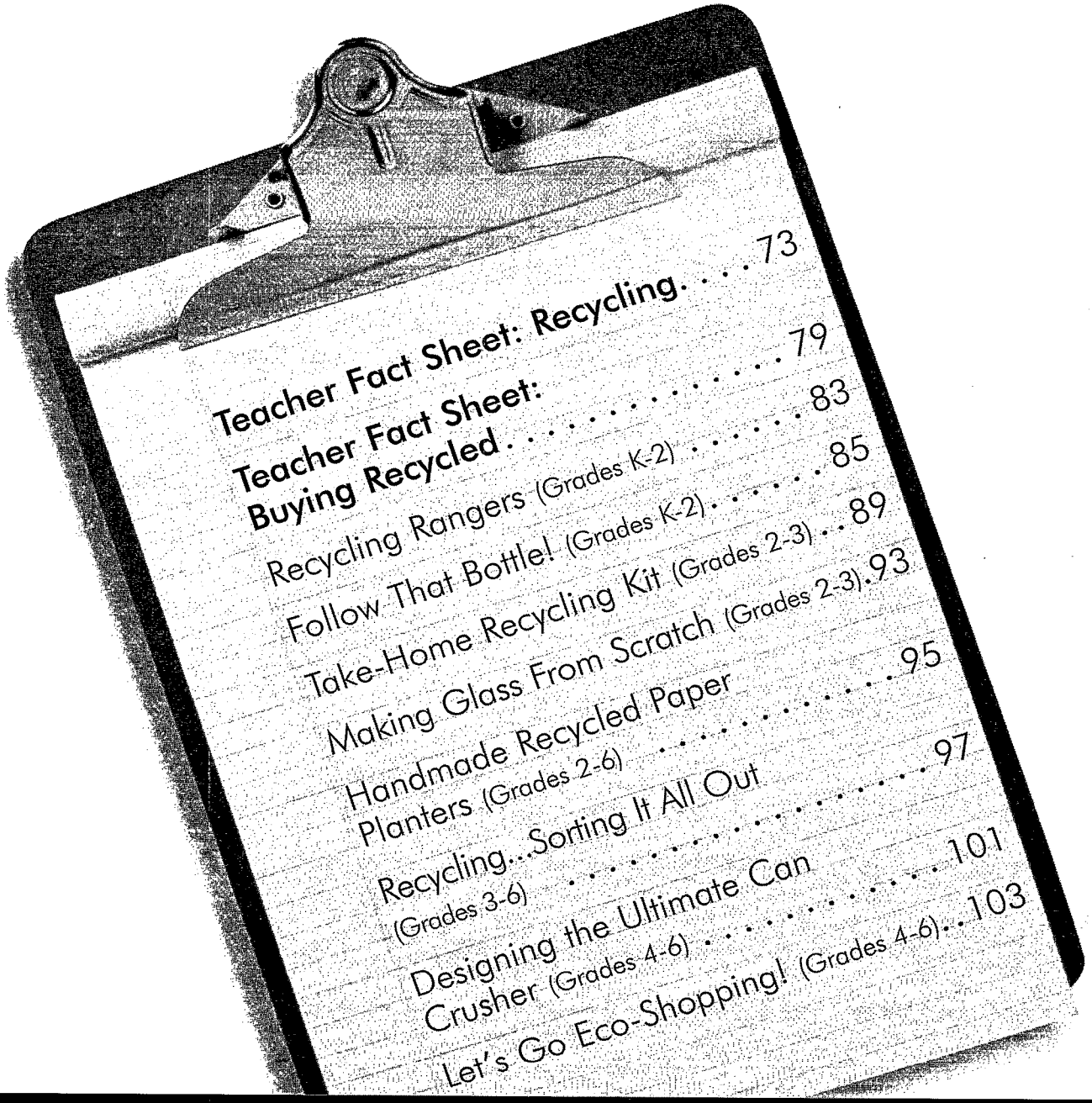
Recycling, Composting, Source Reducing, Landfilling, or Combusting

In this unit, teachers and students will learn the basics of the common solid waste management options used in the United States today. They will learn how to prevent waste before it is even created (known as source reduction), the mechanics and benefits of recycling and buying recycled products, how to make and use compost, and the realities of waste disposal through landfilling and combustion. By learning that trash doesn't just "go away," students will gain an appreciation for how their everyday actions and decisions affect the environment.



CHAPTER 1

Recycling



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Grade • Subject • Skills Index

Activity Name	Recycling Rangers	Follow That Bottle!	Take-Home Recycling Kit	Making Glass From Scratch	Handmade Recycled Paper Planters	Recycling... Sorting It All Out	Designing the Ultimate Can Crusher	Let's Go Eco-Shopping!
Grade Range								
K	✔	✔						
1	✔	✔						
2	✔	✔	✔	✔	✔			
3			✔	✔	✔	✔		
4					✔	✔	✔	✔
5					✔	✔	✔	✔
6					✔	✔	✔	✔
Subjects Covered								
Math				✔		✔	✔	
Science				✔	✔	✔	✔	
Language Arts			✔					✔
Social Studies	✔			✔				✔
Art		✔	✔		✔		✔	✔
Health								
Skills Used*								
Communication	✔		✔	✔		✔		✔
Reading				✔				
Research						✔	✔	✔
Computation						✔	✔	
Observation/ Classification	✔			✔		✔		✔
Problem Solving				✔				✔
Motor Skills		✔	✔		✔		✔	

*See Glossary of Skills for more details.

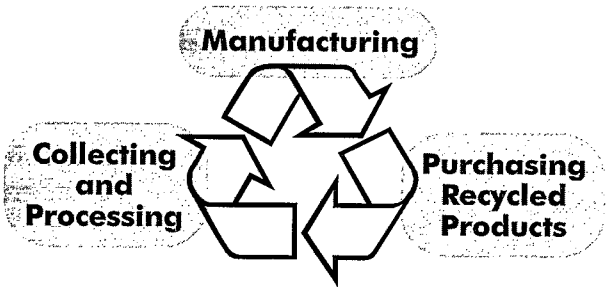
Recycling

What Is Recycling?

Recycling is a series of activities that includes the collection of items that would otherwise be considered waste, sorting and processing the recyclable products into raw materials, and remanufacturing the recycled raw materials into new products. Consumers provide the last link in recycling by purchasing products made from recycled content. Recycling also can include composting of food scraps, yard trimmings, and other organic materials. (See the Teacher Fact Sheet titled *Composting* on page 109 for more information.)

How Does Recycling Work?

Many people already recycle items like paper, glass, and aluminum. While these efforts are a vital part of the process, the true recycling path continues long after recyclables are collected from household bins or community drop-off centers. Collecting, processing, manufacturing, and purchasing recycled products creates a closed circle or loop that ensures the overall success and value of recycling.



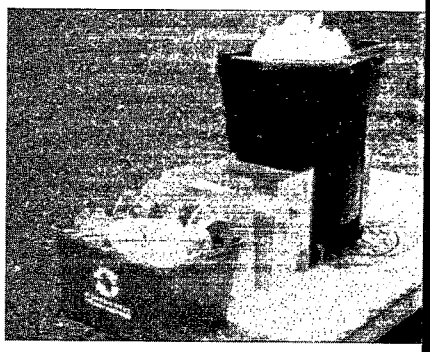
Collection

How and where recyclables can be collected vary by community. Some communities collect from residences, schools, and businesses; four primary methods are used:

- **Curbside collection programs** are the most common. Residents set recyclables, sometimes sorted by type, on their curbs to be picked up by municipal or commerical haulers.
- **Drop-off centers** are locations where residents can take their recyclables. These centers are often sponsored by community organizations.
- **Buy-back centers** are local facilities where recycled-content manufacturers buy their products back from consumers to remanufacture the used products into new products.

Key Points

- The latest numbers show that the recycling rate in the United States has reached an all-time high—in 1997 the country recycled 28 percent of its municipal solid waste.
- Recycling includes collecting materials and sorting and processing them into recycled raw materials to be remanufactured into new products.
- Recycling can only be effective if people buy recycled-content products.
- Recycling reduces the use of virgin materials, reduces the pollution and energy used in manufacturing and processing, saves landfill space, and creates jobs and revenue.
- New methods for the recycling and reuse of certain items, such as computer and electronic equipment, are being developed to prevent waste and save additional materials and energy.



- **Deposit/refund programs** require consumers to pay a deposit on a purchased product. The deposit can be redeemed when the consumer brings the container back to the business or company for recycling.

Processing

After collection, some recyclables are "processed" and prepared for delivery to manufacturing facilities. Processing usually includes making sure the materials are sorted properly and that contaminants (i.e., nonrecyclables) are removed. Recyclables are then usually sent to a materials recovery facility (MRF, pronounced "murph") to be further sorted and then processed into marketable commodities for remanufacturing. Recyclables are bought and sold just like any other commodity, and prices for the materials change and fluctuate with the market. Each MRF has individual requirements about what materials it will accept, but most accept newspapers, aluminum cans, steel food cans, glass containers, and certain types of plastic bottles.

Follow A Plastic Bottle Beyond the Bin...

After a plastic soda bottle is collected in a recycling bin, it is sorted and transported to a materials recovery facility. There it is cleaned and fed into a granulator that chops it into uniform-sized pieces, called "flakes." A manufacturer then purchases the flakes and melts them, squeezing the plastic into thin spaghetti-like strands and chopping those strands into small pieces called "pellets." These plastic pellets are further stretched and squeezed into thin fibers that can be remanufactured into items like clothing, bags, bins, carpet, plastic lumber, hospital supplies, housewares, packaging, shipping supplies, toys, and more. Consumers then complete the recycling loop by purchasing and using these new recycled-content products.

Manufacturing

Once cleaned and sorted, the recyclables move to the next part of the recycling loop—manufacturing. More and more of today's products are being manufactured with recycled content.

- Recycled cardboard and newspaper are used to make new boxes, papers, and other products such as tissues, paper towels, toilet paper, diapers, egg cartons, and napkins.
- Recycled plastic called PET, which is found in soft drink, juice, and peanut butter containers, is used to make new products such as carpets, fiberfill (insulating material in jackets and sleeping bags), bottles and containers, auto parts, and paint brushes. Another kind of recycled plastic, HDPE, which is used in milk, water, detergent, and motor oil containers, can be remanufactured into trash cans, bathroom stalls, plastic lumber, toys, trash bags, and hair combs. Numbers imprinted on the plastic product indicate from which type of plastic the product has been manufactured and how it can be recycled. Not all communities recycle all types of plastic.
- Recycled glass is used again and again in new glass containers as well as in glasphalt (the roadway asphalt that shimmers in sunlight), road filler, and fiberglass.
- Recycled aluminum beverage cans, one of the most successful recyclables, are remade into new cans in as little as 90 days after they are collected. Recycled aluminum cans also can be used in aluminum building materials.
- All steel products manufactured in the United States contain 25-30 percent or 100 percent recycled steel, depending on the manufacturing process used.

Recycling in the United States Throughout History

Although in recent years the United States has witnessed a major increase in public participation in recycling programs, industrial and commercial recycling has always made sense economically. In fact, recycling played an important role in America's success in both world wars. See the time line below for a brief glimpse of recycling throughout history.

Late 1800s to Early 1900s

- Before the days of mass production, the economic climate required people to routinely repair, reuse, and recycle their material possessions.
- Scrap yards recycled old cars, car parts, and metal goods.
- The paper industry used old rags as its main source of fiber until the late 19th century.
- Retailers collected used cardboard boxes for recycling.

1914–1918 and 1939–1945 (WWI and WWII)

- Patriotism inspired nationwide scrap drives for paper, rubber, and other materials to help the war effort.
- Many farms melted down and recycled iron or metal pieces of rusted machinery for warships, vehicles, and other military machines.
- People even saved grease from meat they cooked, which was used to make munitions.

1960s

- Interest in recycling waned as America's peacetime economy soared. Rising incomes and widespread, affordable, mass-produced goods created the "disposable" society.

1970s

- Environmental awareness rejuvenated the nation's interest in recycling.
- U.S. Environmental Protection Agency (EPA) was established December 2, 1970.
- The first Earth Day was held in 1970, significantly increasing recycling awareness. In the years following, 3,000 volunteer recycling centers opened and more than 100 curbside collection programs were established.
- EPA and some state agencies developed guidelines, technical assistance, and targets for local efforts.

1980s

- The national spotlight fell on monitoring trash due to increased awareness of pollution resulting from poor waste management.
- Federal, state, and local governments became more and more involved in waste management.
- Waste management firms began to offer recycling programs in connection with proposals for new incinerators or landfills.

1990s

- Industry expanded the range of products made from recycled materials instead of virgin raw materials.
- National recycling rate reached double digits (28.2 percent in 1998).

2000s

- EPA has set a national recycling goal of 35 percent by 2005.

Recycling Facts

- By recycling 1 ton of paper, we save: 17 trees, 7,000 gallons of water, 380 gallons of oil, 3 cubic yards of landfill space, and enough energy to heat an average home for 6 months.
- Manufacturers can make one extra-large T-shirt out of only five recycled plastic soda bottles.
- Americans throw away enough aluminum every 3 months to rebuild our entire commercial air fleet.
- When one ton of steel is recycled, 2,500 pounds of iron ore, 1,400 pounds of coal, and 120 pounds of limestone are conserved.
- Recycling aluminum cans saves 95 percent of the energy required to make aluminum cans from scratch.
- The amount of aluminum recycled in 1995 could have built 14 aircraft carriers.

(Sources: Weyerhaeuser Company, 1999; Steel Recycling Institute, 2000; American Forest and Paper Association, 2000; R.W. Beck, 1997; The Can Manufacturers Institute, 1997; Anchorage Recycling Center, 2000; Recyclers' Handbook by Earthworks Group, 1997; EPA, 1997)

159 for more information.) In 1997, this country recycled 28 percent of its waste, a rate that has almost doubled over the past 15 years. Of that 28 percent, here is the breakdown of what the United States recycled that year:

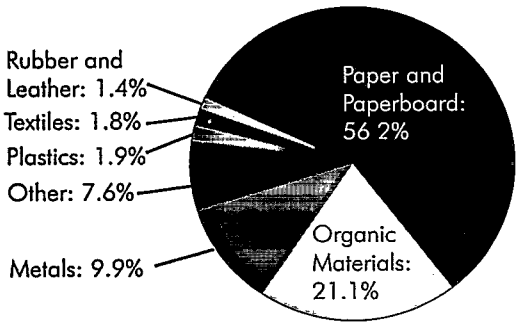
As individuals, businesses, and governments in the United States have increasingly assumed responsibility for wastes, recycling, reuse, and composting have all undergone a phenomenal surge in popularity and success. Analysts project that Americans will be recycling and composting at least 83 million tons—35 percent of all municipal waste—by 2005.

Purchasing Recycled Products

The market for recycled materials is the final part of the recycling loop. Recycled products must be bought and used in order for the entire recycling process to succeed.

Recycling and composting activities divert about 62 million tons of material from landfills and incinerators. (See the Teacher Fact Sheets titled *Landfills* on pg. 155 and *Combustion* on pg.

Materials Recycled in the United States



Source: EPA, 1998

What Are the Benefits of Recycling?

When each part of the recycling loop is completed, the process helps both the environment and the economy. Recycling prevents materials from being thrown away, reducing the need for landfilling and incineration. In addition, the use of recycled materials to manufacture new products prevents pollution caused by the manufacturing of produces from virgin materials. Also, using recycled materials for manufacturing decreases emissions of greenhouse gases that contribute to global climate change. Since the use of recycled materials reduces the need for raw material extraction and processing, energy is saved and the Earth's dwindling resources are conserved.

Recent studies indicate that recycling and remanufacturing account for about one million manufacturing jobs throughout the country and generate more than $100 billion in revenue. Many of the employment opportunities created by recycling are in areas where jobs are most needed.

Recycling in Action

For recycling to work, everyone has to participate in each phase of the loop. From government and industry, to organizations, small businesses, and people at home, all Americans can easily make recycling a part of their daily routine. Below are some ways for individuals to get involved in recycling:

- Learn about and participate in a community recycling program. Know the collection schedule or drop-off location as well as which items are acceptable. Get involved by volunteering with a homeowner's association or community organization to educate neighbors about the recycling program.
- Empty all fluids and remove all lids from bottles and cans when recycling and do not contaminate recycling containers with trash.
- Participate and encourage colleagues to recycle in the containers provided in your school. Initiate a recycling program in your school if one does not exist.
- Make the effort to find recycling opportunities for items, such as plastic packaging, that are not included in your local recycling program.
- Use recyclable products and encourage others to do the same.

What Are the Challenges of Recycling?

Despite its success, the potential of recycling in this country is not yet fully realized. Some plastics, for example, such as bottles and containers, are recyclable in almost any community, but others, such as plastic "peanuts" used in packaging, usually can not be included in curbside or drop-off recycling programs. These items still end up in the trash because it is not profitable to collect the tons needed for remanufacture into new products.

In addition, the costs of collecting, transporting, and processing recyclables can sometimes be

Is Your School Waste Wise?

WasteWise is a voluntary EPA partnership program that helps businesses, governments, and institutions reduce waste and save money. Since the program began in 1994, WasteWise partners have reduced their municipal solid waste by more than 26 million tons! In 1998 alone, partners saved an estimated $264 million. Partners include many large corporations, small and medium-sized businesses, hospitals, tribes, and state, local, and federal governments, as well as 87 schools, school districts, colleges, and universities in more than 30 states.

The following are examples of the accomplishments of a few WasteWise partners in the education field. Alden Central School of New York, which educates children from K-12, implemented a comprehensive waste reduction program in all campus buildings. Students and staff eliminated 450 pounds of polystyrene cafeteria trays and dishes by switching to reusable products. They also composted 900 pounds of cafeteria food scraps and 150 pounds of yard trimmings for use as mulch on building grounds. Sligo Adventist School of Maryland also implemented several innovative waste prevention activities including the reduction of more than 1 ton of drink boxes by switching to bulk juice dispensers. Eastern Illinois University reduced the amount of computer paper used on campus by 10 percent and reused 13 tons of office supplies through an internal exchange among employees.

To find out how your school can join the WasteWise program, please call 800-EPA-WISE (372-9473), e-mail at ww@cais.net, or visit the Web site at <www.epa.gov/wastewise>.

higher than the cost of disposing of these materials as waste. The average cost to process a ton of recyclables is $50, while the average value of those recyclables on the market is only $30. Processors often compensate for this discrepancy by charging a set fee for each ton of material they receive or by establishing ongoing contracts with communities or haulers. Efforts to better manage waste and recycling programs are under development. Many communities across the country implement financial incentives to encourage people to recycle. Residents are charged a fee based on the amount of solid waste they throw away. The more a household recycles, the less garbage it throw outs, and the lower the collection fee it pays.

Finally, recycling facilities are not always a welcome addition to a community. As with other waste management operations, recycling facilities are often accompanied by increased traffic, noise, and even pollution. Community leaders proposing the location for a recycling facility can encourage the NIMBY (Not in My Backyard) sentiment.

Additional Information Resources:

Visit the following Web sites for more information on recycling and solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA, Office of Solid Waste site on recycling: <www.epa.gov/epaoswer/non-hw/muncpl/reduce.htm>
- U.S. EPA, Office of Solid Waste WasteWise Program site: <www.epa.gov/wastewise/index.htm>
- U.S. EPA, Office of Solid Waste site on global climate change and recycling: <www.epa.gov/mswclimate/index.htm>
- U.S. EPA, Office of Solid Waste, Kid's Page: <www.epa.gov/wpaoswer/osw/kids.htm>
- U.S. EPA, Region 9 Office's Recycling Site for Kids: <www.epa.gov/recyclecity>
- National Recycling Coalition: <www.nrc-recycle.org>
- Institute for Scrap Recycling Industries: <www.isri.org>
- American Plastics Council: <www.plastics.org>
- Steel Recycling Institute: <www.recycle-steel.org/>
- Aluminum Association: <www.aluminum.org>
- Glass Packaging Institute: <www.gpi.org>
- American Forest and Paper Association: <www.afandpa.org>
- Institute for Local Self-Reliance: <www.ilsr.org>
- Rechargeable Battery Recycling: <www.rbrc.org>
- Polystyrene Packaging Council: <www.polystyrene.org>

To order the following additional documents on municipal solid waste and recycling, call EPA toll-free at 800 424-9346 (TDD 800-553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *Characterization of Municipal Solid Waste in the United States*
- *Planet Protectors Club Kit* (EPA530-E-98-002)
- *A Resource Guide of Solid Waste Educational Materials* (www.epa.gov/epaoswer/general/bibligr/educat.htm)
- *A Collection of Solid Waste Resources*—CD-ROM

Buying Recycled

What Is "Buying Recycled?"

"Buying recycled" means purchasing items that are made from **postconsumer** recycled content—in other words, materials that were used once and then recycled into something else. This process is also known as "**closing the loop.**"

Consumers "close the loop" when they purchase products made from recycled materials. After an item has been collected for recycling, sorted and processed, and remanufactured into a new product, it still has one more critical step to undergo: purchase and reuse. If no one buys **recycled-content products**, the entire recycling process is ineffective.

Key Points

- Buying recycled-content products encourages manufacturers to purchase and use recycled materials.
- Buying products with "postconsumer" content closes the recycling loop.
- Not all recyclable products can be recycled in every community.
- Buying recycled products saves energy, conserves natural resources, creates jobs, and reduces the amount of waste sent to landfills and incinerators.
- Today's recycled-content products perform just as well, cost the same or less, and are just as available as their nonrecycled counterparts.
- New products containing recycled materials, from construction materials to playground equipment to computers, are constantly being developed.

How Can People "Close the Loop?"

Consumers hold the key to making recycling work. Many manufacturers are already making the use of recycled materials a part of their official company policy. By buying recycled-content products, consumers can encourage this trend, making each purchase count toward "closing the loop." Purchasing recycled-content goods ensures continued availability of our natural resources for the future.

The first step in buying recycled-content products is correctly identifying them. As consumers demand more environmentally sound products, manufacturers are encouraged to highlight these aspects of their merchandise. While this trend is good, shoppers should be aware of the various uses of "recycled" terminology. To help consumers decipher product claims about recycled content, the

A Recycled Product Shopping List

More than 4,500 recycled-content products are already available in stores, and their numbers are rapidly growing. Some of the everyday products people regularly purchase contain recycled-content. Here are some items that are typically made with recycled materials:

- Aluminum cans
- Cereal boxes
- Egg cartons
- Motor oil
- Nails
- Trash bags
- Comic books
- Newspapers
- Paper towels
- Carpeting
- Car bumpers
- Anything made from steel
- Glass containers
- Laundry detergent bottles

Federal Trade Commission has issued guidelines to ensure that products are properly and clearly labeled. Here are some basic definitions:

- **Recycled-content products** are made from materials that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process or after consumer use. Recycled-content products also include products made from used, reconditioned, and remanufactured components.
- **Postconsumer content** indicates that materials used to make a product were recovered or otherwise diverted from the solid waste stream after consumer use. If this term is not noted, or if the package indicates a total recycled content with a percentage of postconsumer content (e.g., 100 percent recycled, 10 percent postconsumer), the rest of the material probably came from excess material generated during normal manufacturing processes. These materials were not used by a consumer or collected through a local recycling program.
- **Recyclable products** can be collected, separated, or otherwise recovered from the solid waste stream for use in the form of raw materials in the manufacture of a new product. This includes products that can be reused, reconditioned, or remanufactured. These products do not necessarily contain recycled materials and only benefit the environment if people recycle them after use. Not all communities collect all types of products for recycling, so it is really only recyclable if your community accepts it.
- **Products wrapped in recycled or recyclable packaging** do not necessarily contain recycled content. They can be wrapped in paper or plastic made from recycled materials, which is a good start, but the most environmentally preferable packaging is none at all.

Consumers must remember to read further than the recycling symbol or the vague language to find specific and verifiable claims. When in doubt about the recycled content of an item, asking the store clerk will not only help to inform the consumer, but also raise the store clerk's awareness of shoppers' interest in environmentally preferable products.

Buy-Recycled Facts

- Aluminum cans contain an average of 50 percent recycled postconsumer content, while glass bottles contain an average of 30 percent.
- How many recycled plastic soda bottles does it take to make...?
  1 XL T-shirt.....5 bottles
  1 Ski jacket filler.....5 bottles
  1 Sweater .....27 bottles
  1 Sleeping bag.....35 bottles
- Manufacturers in the United States bought $5 billion worth of recycled materials in 1995.
- One 6-foot-long plastic park bench can be made from 1,050 plastic milk jugs.

(Sources: Aluminum Association, 2000; Glass Packaging Institute; Recyclers' Handbook by Earthworks Group, 1997; Anchorage Recycling Center, 2000; American Plastics Council, 1999; National Recycling Coalition)

What Are the Benefits of Buying Recycled?

Important advantages to buying recycled content products include:

- **Waste and Pollution Prevention:** Manufacturing products with recycled-content generally creates much less waste and pollution, ranging from truck emissions to raw material scraps.
- **Resource and Energy Conservation:** Making a new product from recycled-content materials generally reduces the amount of energy and virgin materials needed to manufacture the product.

- **Economic Development:** The Institute for Local Self-Reliance in Washington, DC, estimates that nine jobs are created for every 15,000 tons of solid waste recycled into a new product. These jobs range from low-skilled to high-skilled positions, including materials sorters, dispatchers, truck drivers, brokers, sales representatives, process engineers, and chemists.
- **Money Savings:** Products such as re-refined motor oil, retreaded tires, and remanufactured automotive batteries will often cost less than their virgin material counterparts.

What Are the Challenges of Buying Recycled?

Many people incorrectly assume that products made from recycled content, or used material, are inferior in quality to entirely new products. The challenge is to correct that misconception and convince businesses and consumers of the reliability of recycled-content products. According to the California Department of Conservation and the California Integrated Waste Management Board, in 1996, 97 percent of corporate purchasing agents reported that they were pleased with the performance of their recycled-content products. Though each product's quality and reliability must be judged individually, no evidence exists that recycled-content products are inferior to their virgin material counterparts. Initially, some recycled-content products were less available and harder to find than virgin products, but today, every major national store chain and nearly all small chains or independent retailers carry recycled-content products at competitive prices.

What Are Some Emerging Trends?

A wider variety of recycled-content products are being produced every day. Some newly available items include electronic equipment, such as computers and printers, made from recycled parts; tape measures made from reconditioned and recycled parts; kitty litter made from recycled drywall; recycled-content plastic office products; and innovative clothing and accessories made from recycled tire inner tubes.

Buying Recycled in Action

Consumers hold the power in their wallets and on their shopping lists. Whether buying items for home, school, or work, consumers must think about the environment and the future as they consider products and brands. Below are activities that will help promote buying recycled:

- Buying recycled-content products personally and encouraging the use of recycled products at school.
- Teaching children about "closing the recycling loop" by organizing a tour of a local facility that manufactures recycled-content products, such as steel products.
- Organizing an exhibit of recycled-content products.
- Asking local stores to stock more recycled-content products.
- Looking for products that usually contain recycled materials, such as steel, glass, aluminum, egg cartons (paper), and cereal boxes.
- Purchasing remanufactured products and equipment, like toner cartridges, office furniture, auto parts, re-refined oil, or retreaded tires.
- Purchasing products that can be recycled in local communities.

Additional Information Resources:

Visit the following Web sites for more information on buying recycled products and solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA, Office of Solid Waste site on buying recycled: <www.epa.gov/epaoswer/non-hw/reduce/wstewise/purchase.htm#purchase1>
- U.S. EPA, Office of Solid Waste site on recycling and buying recycled: <www.epa.gov/epaoswer/non-hw/muncpl/reduce.htm>
- King County, Washington: <www.metrokc.gov/oppis/recyclea.html>
- Green Seal: <www.GreenSeal.org>
- The American Plastics Council: <www.plasticsresource.com>
- The Official Recycled Products Guide: <www.recyclingdata.com>
- The Global Recycling Network: <www.grn.com>
- The Environmental News Network's Marketplace: <www.enn.com/marketplace/index.htm>
- Pennsylvania Resource Council's Recycling and Solid Waste Center: <www.prc.org/recctr.htm>
- Buy Recycled Business Alliance: <www.nrc-recycle.org/brba/index.htm>

To order the following additional documents on buying recycled and solid waste, call EPA toll-free at 800 424-9346 (TDD 800 553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>

- *The Consumer's Handbook for Reducing Solid Waste* (EPA530-K-96-003)
- *A Collection of Solid Waste Resources*—CD-ROM

EPA's WasteWise Program helpline (800 EPA-WISE) has additional resources available. These resources include information on the following:

- State Buy-Recycled Contacts
- *Buy Recycled Guidebook*

Recycling Rangers

social studies

Objective

To help children recognize the similarities and differences among common recyclable items.

Activity Description

Students play a sorting game and put different recyclables into the appropriate bin.

Materials Needed

- Four recycling bins
- Recyclable materials listed in the box below

Key Vocabulary Words

Paper
Plastic
Glass
Metals

Duration

1 hour

Skills Used

Communication
Observation/classification

Activity

Step 1: Set up the four bins in the classroom and label them "Paper," "Glass," "Plastic," and "Metals." Make a pile of all of the recyclable items on the floor and ask the students to gather around them in a circle.

Step 2: Explain to students that by the end of the lesson they will become "Recycling Rangers" and learn how to recycle different items. Discuss with the students how different "garbage" items can be recycled into new products. Note that it is important to separate these items into different categories before they are used to make new products. Refer to the Teacher Fact Sheet titled *Recycling* on pg. 73 for background information on the recycling process.

Step 3: Ask the students to look at the different recyclable materials and discuss how they are alike and how they are different. Ask them

Recyclable Materials

— Cardboard
— Newspapers
— Magazines
— Plastic soda bottles
— Plastic milk containers
— Glass jars or bottles
— Aluminum cans
— Steel food cans
— Other materials recycled in your community

Note: All materials should be cleaned and all sharp lids or edges should be removed or taped over to avoid injury.

to compare the colors, textures, and weight of the different objects. When handling the glass bottles, take great care not to accidentally break the containers. Also, note that some metal containers have sharp edges that can cause injury to the children.

Step 4: Moving through the pile one item at a time, ask the students to identify the material that each item is made from. Then, choose a student volunteer to place the item in the appropriate bin. For the older children, ask the student volunteer to also name another product that is made from that same material. If a student, for example, is holding a glass jelly jar, he or she could note that soda bottles are also made of glass.

Step 5: After the lesson is concluded, encourage students to go home that night and share what they learned with their parents.

Assessment

1. Ask students to name some examples of recyclable items.
2. Have students explain why it is important to sort the different recyclable items.
3. Ask students what kinds of materials recyclable items are made from.

Enrichment

1. Select a few objects from the lesson, ensuring a good mix of shapes and sizes. Ask the children to trace outlines of the objects and then color them in. Put the pictures up on the classroom wall to create a recycling art gallery.
2. Organize the class into teams of four children and give each group a different recyclable item. Ask the students to make a new object from the recycled items such as a crayon holder or paper plane.

Follow That Bottle!

Objective

To show students the various steps involved in recycling.

Activity Description

While coloring, students will follow the path of the bottle in the *Follow That Bottle!* worksheet.

Materials Needed

- Copies of the *Follow That Bottle!* worksheet for each member of the class
- Crayons

Key Vocabulary Words

Recycling
Processing
Manufacturing
Factory

Duration

1 hour

Skills Used

Motor skills

Activity

Step 1: Using the storyline in the *Follow That Bottle!* worksheet, discuss the life of a recyclable item, such as a plastic bottle, after it is placed in the recycling bin. Explain that items such as bottles, cans, and newspapers can be made into a new product—either the same kind of product or a completely different product—if they are recycled and not thrown away. (Refer to the Teacher Fact Sheet titled *Recycling* on pg. 73 for background information.)

Step 2: Read and then distribute the *Follow That Bottle!* worksheet and instruct the students to follow the bottle by coloring it with crayons as it is used, recycled, remanufactured, and made into a new product. As the students color, ask them what they think is happening in each section of the picture. Ask them, for example, if anyone has been to a factory or if they recycle at home.

Step 3: After talking about the life of the bottle, students can color the rest of the story board.

Assessment

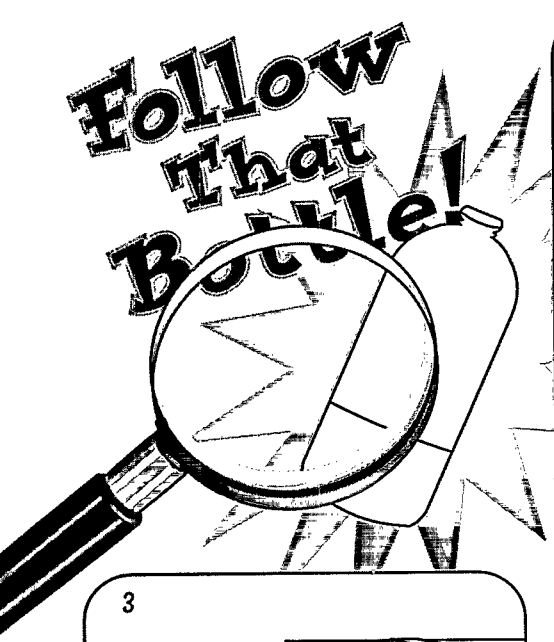
1. Have students explain what happens to a plastic bottle, or other recyclable, after it is placed in a recycling bin.
2. Ask students to describe their own recycling experiences. Do they use a bin?

Enrichment

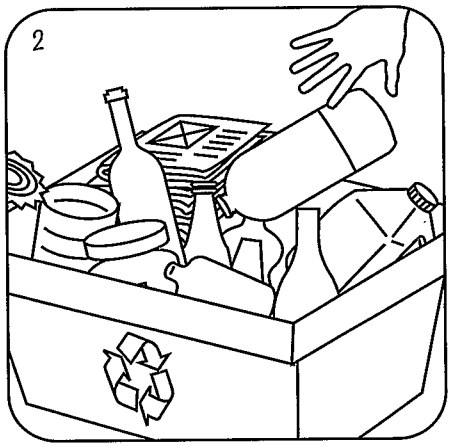
1. Instruct the students to draw a picture of themselves as they recycle common products.
2. Have students sort and separate recyclables from lunch for one week to get a sense of the items that can be recycled in your community. Prepare separate bins for each recyclable.
3. Ask students what happens to the plastic bottle if it does not go in the recycling bin.

Student Handout

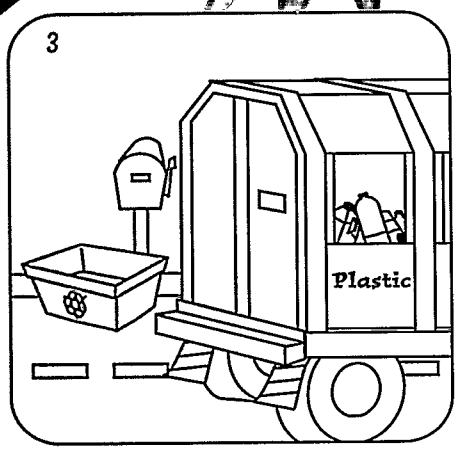
Name: _____



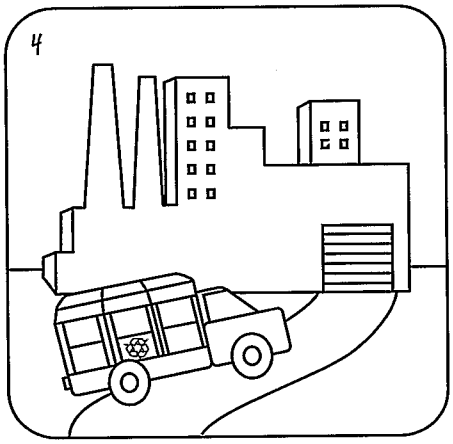
Billy drinks a soda.



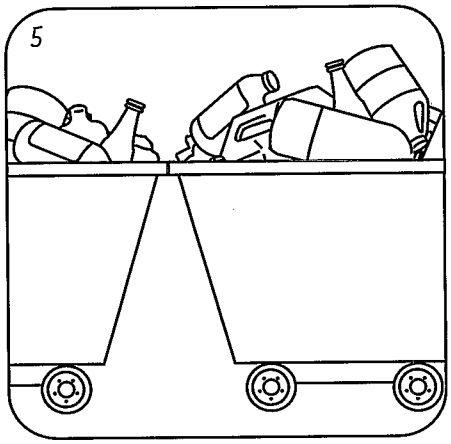
When he is finished, he puts the empty bottle in the recycling bin.



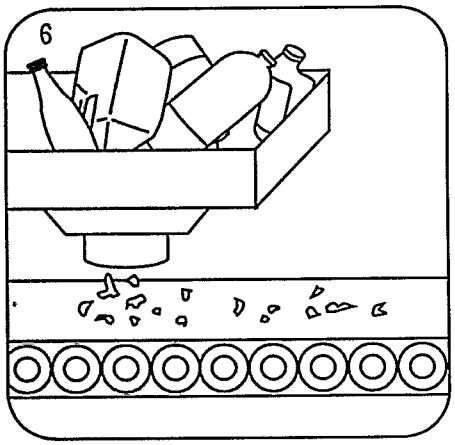
A truck comes to pick up the recycled bottles.



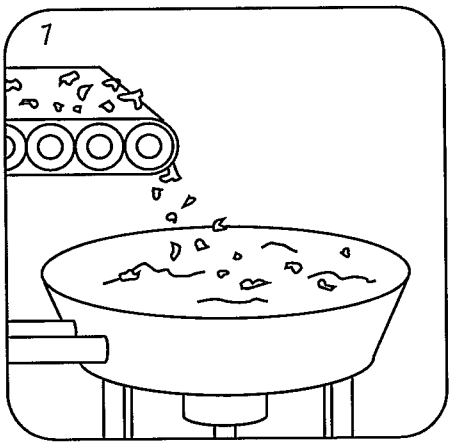
The truck takes the recycled bottles to a factory.



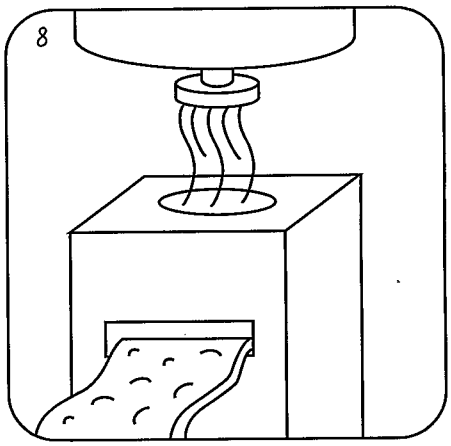
The bottles get separated by color.



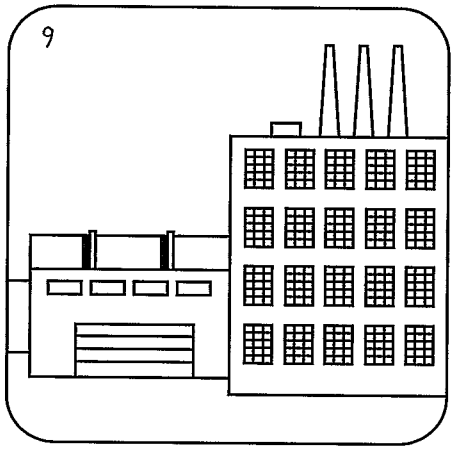
The bottles are ground up into little pieces.



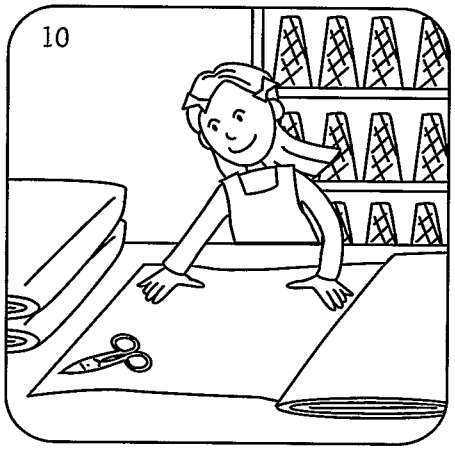
The little plastic pieces are melted...



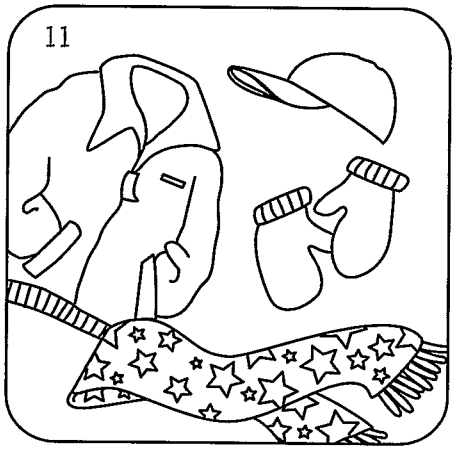
...and made into pieces of thread.



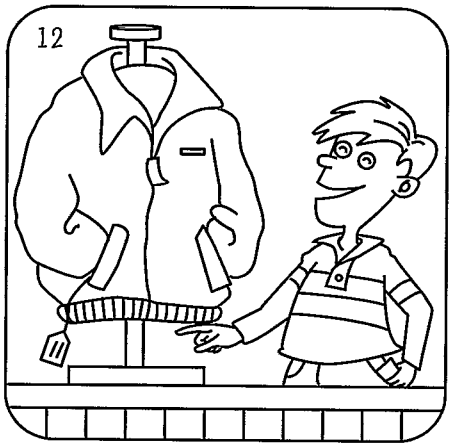
In another factory...



...the plastic thread is used to make clothing.



Jackets, scarves, gloves, and blankets can be made from recycled soda bottles...



...and are sold in stores.

Billy's favorite jacket is made from the soda bottles he recycled!

Take-Home Recycling Kit

Suggestion for Teachers: You might want to find out what materials are collected for recycling in your community before beginning this activity.

Objective

To teach students the value of recycling and encourage them to discuss recycling with their families.

Activity Description

Students will assemble a take-home recycling kit.

Materials Needed

- *Recycling Facts* handout for each member of the class
- Old magazines and newspapers
- Used cardboard
- Construction paper
- Markers and/or paint
- Glue
- Scissors
- Any other arts and crafts supplies available

Key Vocabulary Words

Recycling
Processing

Duration

2 hours

Skills Used

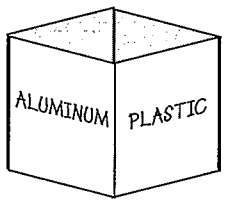
Communication
Motor skills

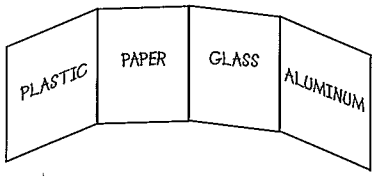
Activity

Step 1: Explain how recycling works and the important role we all can play by recycling items instead of throwing them away. (Refer to the Teacher Fact Sheet titled *Recycling* on pg. 73 for more information.) Review the information on the following *Recycling Facts* handouts with the students, pointing out the economic and environmental benefits of recycling.

Step 2: Have each student cut the old cardboard boxes into four 8 ½- by 11-inch pieces and glue different colored sheets of construction paper to each side of the cardboard. Connect each piece of cardboard with tape to form a placard that can stand on a table. Instruct the students to label each cardboard piece with one of the following recyclables: aluminum, glass, plastic, and paper (see examples below).

Step 3: Instruct the class to cut out or draw the appropriate recyclable for each cardboard placard using the magazines, newspapers,





Journal Activity

Ask students to interview their family members about recycling practices and views on recycling. Ask students to write a short article on their families' current views and how their recycling kit changed those views or practices.

markers, and paints. Ask students to write information about recycling on each placard. Optional recycling facts are included on the attached handout and might assist students in this task.

Step 4: When the students are finished decorating their placards, ask them to take them home and affix them where their family keeps its recyclables or its trash to encourage families that don't already recycle to start. Ask students to share the information they learned about recycling with their parents. Explain how the placards serve as friendly reminders of the importance and benefits of recycling.

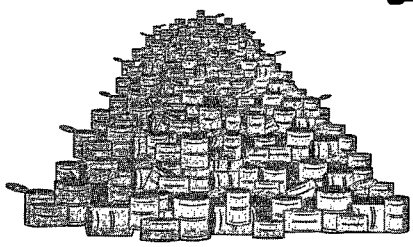
Assessment

1. Ask students to list the ways recycling helps the environment and why these benefits are important.
2. Ask students what role each of us can play in recycling.

Enrichment

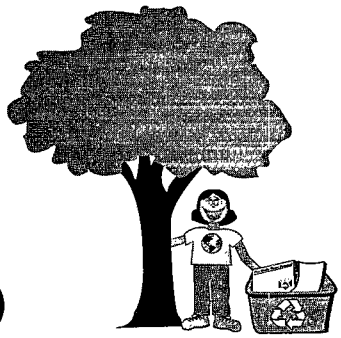
1. If your community recycles, but the majority of the class' families do not recycle at home, have the students practice a "recycling pitch" to their parents using their placards and other facts about the benefits of recycling. Also, students could develop a commercial using their placards and draw a story board of it or create a skit that is then videotaped.
2. Make signs for the classroom or school recycling bin. Ask students to put cans, bottles, or other items from their lunches in the recycling bins in the classroom or school. When the bins are full, take them to a collection facility and use the money to buy treats for the class.
3. Organize a tour of a recyclables processing facility or a manufacturing plant that uses recycled materials.

Recycling Facts



Paper

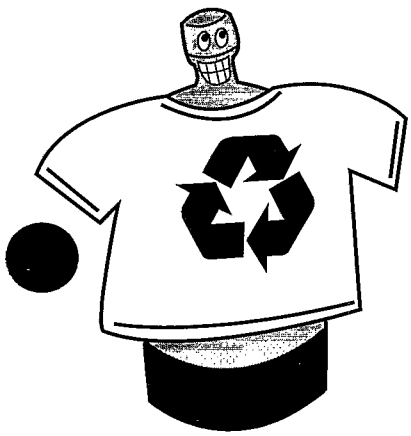
- A used newspaper can be recycled and remanufactured into a new newspaper in less than 4 weeks.



- Americans recycled 60,000 tons of phone books in 1995.
- By recycling or reusing 1 ton of paper, we save 17 trees, 7,000 gallons of water, 380 gallons of oil, 3 cubic yards of landfill space, and enough energy to heat an average home for 6 months.
- Americans recycled 47 million tons of paper in 1999.

Plastic

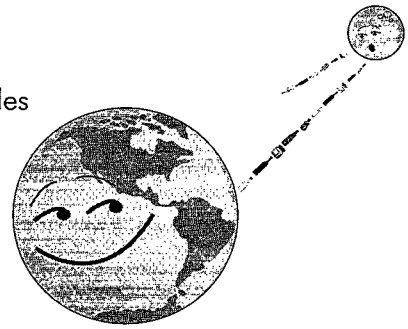
- Using only five recycled plastic soda bottles, manufacturers can make one extra-large T-shirt.
- Milk jugs can be made into all different types of plastic objects, from park benches to boardwalks.
- Recycled plastic soda bottles can be made into "fleece" sweaters, long underwear, stuffing for sleeping bags, and other items.



Aluminum

- Recycling aluminum cans saves 95 percent of the energy required to make aluminum cans from scratch.
- Since 1972, Americans have earned $10 billion from recycling aluminum cans.
- Every minute, an average of 127,093 aluminum beverage cans are recycled in the United States.
- The amount of aluminum recycled in 1995 could have built 14 aircraft carriers

Glass



- If all the glass bottles and jars recycled were laid end-to-end, they would reach the moon and make it more than halfway back to Earth.
- Every day, Americans recycle 37 percent of all glass jars and bottles.
- Americans throw away enough glass bottles and jars every 2 weeks to fill both of the World Trade Center's 1,350-foot towers.
- Every ton of new glass produced results in 27.8 pounds of air pollution, but recycling glass reduces that pollution by 14 to 20 percent.

Sources: National Recycling Coalition; EPA; Weyerhaeuser Company,1999; American Forest and Paper Association; American Plastics Council; 1994; Coca-Cola Co., 1995; Glass Packaging Institute, 2000; Can Manufacturers Institute, 2000; EPA, 1997.

Making Glass From Scratch

math

science

social studies

Objective

To teach students about the processes and resources used in the manufacture of glass and to introduce how recycling glass is good for the environment.

Activity Description

Students make a glass-like substance using sugar and water.

Materials Needed

- 1 cup sugar
- 1/4 cup water
- Hot plate and sauce pan or hot pot (to boil water)
- 8-inch square sheet of glass or a cookie sheet
- Newspaper
- Assorted glass objects

Key Vocabulary Words

Glass
Heat
Energy
Natural resources
Reuse
Recycle
Resource
Minerals
Raw materials

Duration

45 minutes

Skills Used

Communication
Reading
Observation/classification
Problem solving

Activity

Step 1: Discuss how glass is made (i.e., that sand, soda and lime are heated together at high temperatures), emphasizing the heat and energy required during the manufacturing process. Explain to students that glass containers can be remelted or "recycled" to make new glass containers, saving valuable resources in the process. (Refer to the Teacher Fact Sheets titled *Products* on page 25 and *Recycling* on page 73 for background on the manufacturing process.) During the discussion, allow students to touch a variety of different glass objects (e.g., beverage container, jelly jar, vase). Ask them to describe the colors, shapes, and textures of the different items.

Step 2: Begin the glassmaking exercise by heating the water. Tell students you are going to make "pretend" glass using sugar in place of the actual raw material, sand. Let students examine the sugar and describe it in terms of its color, texture, and shape. Point out the similarities between the sugar and sand. Have students describe the water and how it changes as the heat begins to make the water boil (e.g., after the sugar has melted it will look like a brown liquid). Point out the heat energy involved in making the water boil as well as the steam that is produced. Next, pour the sugar into the boiling water. Tell students to pretend the sugar is sand (minerals) from the ground.

Step 3: Stir the mixture vigorously over the heat until the sugar is dissolved (about 5 minutes). Ask students to describe the changes in the sugar and water. Tell them this is how glass looks before it cools.

Step 4: Put several layers of newspaper under a sheet of glass or a cookie sheet. (If you are worried about handling glass, use a cookie sheet—although students will not be able to see through it.) Carefully pour the mixture onto the sheet of glass and allow it to cool (about 15 minutes).

Step 5: Hold up the sheet of "glass" so students can see through it. By allowing it to set overnight, the "glass" will become frosted. The next day, ask students to describe the changes that occurred overnight and why (e.g., the water evaporated leaving sugar crystals behind).

Step 6: As an optional exercise, illustrate glass recycling by scraping the dried "glass" back into the pan (pretending it is small pieces of crushed, recycled glass), adding water, and reboiling the mixture. More sugar will need to be added to repeat the procedure. Ask students which resources were replaced when the crushed glass was used to make the new glass (minerals, energy).

Assessment

1. Ask students what materials are used to make virgin (nonrecycled) and recycled glass bottles. Older students may illustrate the process, labeling the natural resources used to make glass and show which ones are replaced when recycled glass is used as a raw material.
2. Have students describe how recycling glass is good for the environment.

Enrichment

1. Perform a molding glass exercise. For this project, you will need one wide-mouth glass jar per group of four to six students, and one stiff straw or glass tubing, balloon, and rubber band per student. To begin, divide the class into small groups of four to six students and give each group a wide-mouth jar. Next, give each student a straw or glass tubing, balloon, and rubber band. Assist students in attaching the balloon to the straw with the rubber band. Ask students to take turns putting the balloon into the jar and blowing it up until it takes the shape of the jar. Explain that this process illustrates how glass is molded into a jar or other shape during the manufacture of glass containers.
2. 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 identify the glass as handmade. Visit a glass blower, if possible. These individuals often participate in local crafts festivals or similar events.
3. Ask students to look around their homes for glass products that could be recycled to make new glass. Ask students to make a list of the items and bring the list to class. Have students share their lists and then discuss which items can and cannot be used for recycling (for example, items not commonly accepted for recycling are lightbulbs, mirrors, windows, etc.).

Handmade Recycled Paper Planters

science

art

Objective

To show students how easy it can be to make products from recycled items.

Activity Description

Students will make planters from recycled paper.

Materials Needed

- Large stack of newspapers
- Scissors
- Three to five 2-gallon buckets
- Water
- Egg beaters
- Magnifying glass
- Plant seeds for each student
- Planting soil
- Paper drinking cups

Key Vocabulary Words

Recycle
Fibers
Decompose
Pulp
Virgin materials
Resources

Duration

2-3 hours

Skills Used

Motor skills

Note: Try to reuse a cup-shaped container instead of using paper drinking cups. For example, you could use reusable plastic drinking cups, plastic planter molds, or milk containers.

Activity

Step 1: Introduce the concepts of recycling and decomposition to the class. Explain that making items from recyclables rather than virgin materials benefits the environment by saving natural resources. (Refer to the Teacher Fact Sheets titled *Recycling* on page 73 and *Natural Resources* on page 5 for background information. The *Composting* fact sheet on page 109 contains information on decomposition.)

Step 2: Discuss with the class how paper is made. Explain that most paper is made from only trees, while other paper is made from a combination of trees and old newspaper or used office paper (in addition, a small percentage of paper is made from other fibrous materials such as cotton, papyrus, or rags). Discuss how when recycled paper is used to make new paper, less trees need to be cut down. Help students explore the environmental implications of this.

Step 2: Have each student cut up two full pages of newspaper into ½- to 1-inch square pieces.

Step 3: Ask a few student volunteers to fill the buckets 1/3 full with paper and the remaining 2/3 with water (1 part paper to 2 parts water).

Journal Activity

Ask students to write a story about their seedling's journey from its first days in the planter to when it takes root in the ground outdoors.

Step 4: Let the mixture sit overnight. By the next day, the newspaper fibers will be soft and ready to pulp.

Step 5: On the second day, have students take turns pulping the fibers with the hand beater until the paper and water look like mush. Explain that the pulping process breaks down the fibers into a form that can be bonded together again to make recycled paper. Have students look at the pulp with a magnifying glass to see the loose wood fibers.

Step 6: Give each student a plastic cup-shaped container. Instruct them to mold the pulp to the inside of the cup, squeezing out as much of the water as possible. The pulp should be 1/4- to 1/2-inch thick on the inside of the cup.

Step 7: Let the pulp dry completely over the next 3 days.

Step 8: After the pulp has dried, take the handmade recycled paper cup out of the drinking cup.

Step 9: Give each student a seed and instruct them to plant it in the cup using the planting soil. Keep the planters in the classroom and have the students care for the plants. Discuss how much sunlight and water their plants need.

Step 10: Send the students home with their planters when the seedlings have sprouted and are ready to be planted in the ground. Instruct the students to place the whole cup with the plant in it into the ground.

Students in an urban setting could either plant their seedlings in a local park or decorate their planters and donate the seedlings to a local nursing home. (Students also could give a presentation on recycling to the elderly when they drop off their planters.)

Step 11: Discuss how the planter will decompose in the soil and the plant will take root in the ground. Explain that they have just completed the recycling loop by sending the nutrients from the paper cup back into the soil.

Assessment

1. Ask students where paper comes from.
2. Ask students to explain how making paper from used paper benefits the environment.
3. Ask students how and why the planter will decompose in the ground.

Enrichment

1. On the blackboard or as a handout, work with the students to diagram and label all of the steps that occur in making paper from recycled materials versus making paper from only virgin materials. Discuss the differences.
2. Instead of sending the students home with the seedlings, start a garden at the school and tend it regularly with the class.
3. Have students discuss what else they can do to reduce the number of trees being cut down to make paper.

Recycling...Sorting It All Out

math

science

Objective

To help students test and better understand the properties of different recyclable materials.

Activity Description

Students rotate to different stations to evaluate recyclable items and learn how to sort them into different categories.

Materials Needed

- Recyclable items listed below
- Magnets
- An aquarium tank or other large container filled with water
- Rocks or other items that vary in density
- Balance scale
- Scissors
- Tablespoon of sand
- Copies of the *Sorting Statistics Worksheet*
- Calculators (optional)

Key Vocabulary Words

Sorting
Recyclables
Magnetism
Density
Mass
Matter

Duration

1 hour

Skills Used

Communication
Research
Computation
Observation/classification

Activity

Step 1: A day or two before the lesson, ask students to bring in different recyclable items from home or collect items left over from lunch. See the box at right for the list of materials to request. Be sure to clean these items before the lesson and remove any sharp edges. Store these items in a utility closet or some other storage room at the school until you are ready to conduct the lesson.

Recyclable Items

Steel food cans
Aluminum soda cans
Plastic detergent bottles
Plastic milk jugs
Newspapers
Magazines
Notebook paper
Cardboard boxes

Step 2: To begin the lesson, discuss how waste is reduced by recycling. Explain how after recyclables are collected from businesses and homes, they are sent to a facility where they are sorted into different categories of materials. Explain that it is important for recyclers to tell the difference between materials because they end up being recycled into different products. (Refer to the Teacher Fact Sheet titled *Recycling* on page 73 for more information on this process).

Journal Activity

Ask students if they can think of an innovative way to sort recyclables? Ask them to describe or draw their invention.

Step 3: Organize three different stations throughout the classroom.

Station One should include the steel and aluminum cans, a magnet, and an information sheet about magnetism. This sheet should explain that magnets are pieces of iron or steel that can attract other metals.

Station Two should include the plastic items and a large container (e.g., an aquarium) filled with water, along with scissors and a few heavy and light objects. You should prepare an information sheet explaining that density refers to how compact an object is. As an example, note that a bowling ball is much more dense than a foam rubber ball of the same size because the bowling ball is more compact and made of heavier material.

Station Three should include the paper items and a scale. An information sheet should explain that mass refers to the amount of matter in an object. You can weigh an object on a scale to determine its mass.

Step 4: Once the stations are set up, hand out worksheets, break the students up into groups of three, and explain that students should rotate from station to station in their groups and fill out their worksheet as they go. Students can discuss answers within their groups.

Step 5: At Station One, have students experiment with the magnet and the different cans to discover that some of the cans are attracted to the magnet while others are not. At Station Two, students should compare the density of various plastic items. Students can compare the density of other items with plastic, and can cut up plastic into pieces to see how density is affected. At Station Three, students can place various paper items on the scale and record the different weights.

Step 6: Discuss the questions from the worksheet. Students should understand that recycling sorting facilities use magnets to separate the steel cans from the rest of the collected recyclables. They should also understand that density is important because it can be used to identify and separate different items. Recycling sorting facilities use sinking/floating exercises to sort plastics from other materials, such as crushed glass, since plastic containers float. Students should also understand that sorting facilities use scales to weigh the recyclable materials they receive so they know how much material is being recycled.

Assessment

1. Ask students to explain magnetism. Ask them why only some objects are attracted to magnets. Which ones?
2. Ask students to explain density and how to test for it.
3. Ask students what mass means. Have them explain how to test something to determine its mass.
4. Have students list some of the techniques that sorting facilities use to separate different recyclables.

Enrichment

1. Visit a local recycling materials recovery facility to see firsthand how the different recyclables are sorted.
2. Ask students to draw their own recycling sorting facility. Ask them to start with a pile of recyclables at one end and show how the different recyclables would be separated (e.g., magnets, conveyor belts) as they move through the facility. Ask them to decide whether their diagram will only involve machinery or whether it will involve people to sort some of the items. Ask them to label each of the different stations in the facility and describe how each station works.

Sorting Statistics

Name:

_____

Station One

1. How many steel cans are at Station One? Use the magnet to find out. Now, multiply that number by the number of students in your classroom. If you recycled 56 percent of these cans, approximately how many would that be? As a nation, we recycled 56 percent of our steel cans in 1998.

_____

_____

2. How would magnets help workers at a recycling sorting facility?

_____

_____

3. Suppose you have 10 aluminum cans—5 containing recycled aluminum and 5 with no recycled content (made from bauxite, the primary ore). Next, suppose it takes 5 watts of energy to make a can with recycled aluminum and 100 watts to make a can from bauxite. How much energy does it take to make the 5 recycled-content cans? How about the 5 nonrecycled cans? Note that it takes 95 percent less energy to make an aluminum can from recycled aluminum versus making one from scratch.

_____

_____

4. Calculate the aluminum can recycling rate for Anywhereville, USA, given the following information:

- 1,938 pounds of aluminum cans were recycled
- 3,370 pounds of aluminum cans were produced
- There are an average of 33.04 cans per pound

Number of cans recycled:

_____

Number of cans produced:

_____

Recycling rate:

_____

Student Handout

Station Two

1. Does the size and shape of an object affect its density? Test a few different types of plastic objects in the water and record your results. You can cut up some plastic and try some other objects for comparison—record all results.

_____

_____

2. How is testing for density helpful to a recycling sorting facility?

_____

_____

3. Note that the following formula is used to determine the density of an item: density = mass (grams)/volume (centimeters^3). Now, assume a piece of garbage—a popcorn bag—has a mass of 12 grams and a volume of 5 centimeters^3. What is its density?

_____

_____

4. Note that water has a density of 1.0 g/cm^3. Items that have a density of less than 1 float in water, while those that are more than 1 sink. Do plastic bottles have a density greater or less than 1?

_____

_____

Station Three

1. Describe the characteristics of the different types of paper. How are they similar? How are they different? Consider color, texture, glossiness, thickness, etc.

_____

_____

2. Assuming you recycle 7 newspapers a week, 365 days a year, how many newspapers do you recycle per year?

_____

_____

3. Using the scale at Station Three, weigh a newspaper to determine its mass. Using your answer from question 2, what is the total mass (in pounds) of the newspapers you recycle each year? In tons? (There are 2,205 pounds in a ton.)

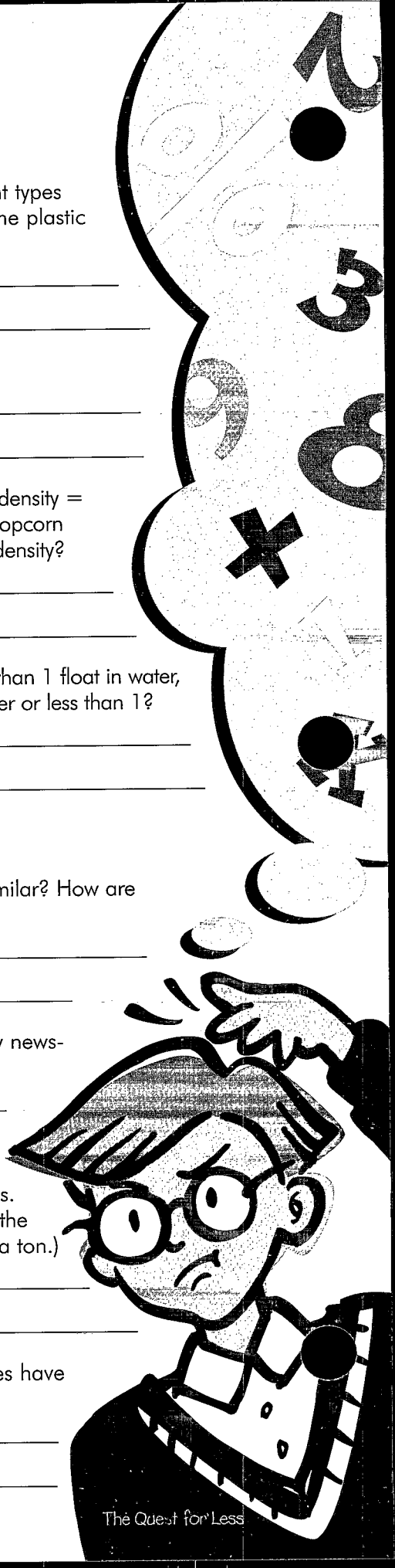
_____

_____

4. Assuming that each ton of paper recycled saves 17 trees, how many trees have you saved by recycling your newspaper each year?

_____

_____



Designing the Ultimate Can Crusher

math
science
art

Objective

To help students understand simple machines and manipulate materials and tools to build their own machine.

Activity Description

Students work in teams to design and construct a machine to crush aluminum cans. Students then vote for the best design.

Materials Needed

- Construction items listed in the box below
- Hammer
- Saw
- Screwdriver
- Pliers
- Wire cutters
- Ruler and/or measuring tape

Key Vocabulary Words

Recycling
Recyclables
Compaction

Duration

Set-up/design: 1 hour
Construction: 1 to 2 hours

Skills Used

Research
Computation
Motor skills

Activity

Step 1: Several days before the lesson, ask students to bring in different construction items from the list to the right. Be sure to store these items in a safe place at the school where students cannot access them and hurt themselves. Also, note that this lesson will work best in a shop room or similar area with plenty of open space and room for students to work.

Step 2: To begin the lesson, introduce the concept of simple machines—levers, pulleys, etc. Next, explain how simple machines are used in the recycling process. Recycling facilities use machines, for example, to crush aluminum cans

Construction Items

Aluminum cans
Rope
Wire
Hinges
Screws
Nails
Wood scraps
Bricks
Blocks
Other construction items

Journal Activity

Ask students to describe the most challenging part of designing their can crusher. Ask them how they overcame this challenge.

to make them easier to store and ship since they require less space when crushed (Refer to the Teacher Fact Sheet titled *Recycling* on page 73 for more information on this process).

Step 3: Divide the class into small groups of four or five students.

Step 4: Place a few aluminum cans on the floor. Ask a volunteer to crush the cans with his or her foot. Have students identify what is involved in crushing a can. Ask them to describe what happens to the can.

Step 5: Have students examine all of the construction materials brought to class. Explain that the job of each group is to use these materials to design and construct a can crushing machine. Each group should use at least one "simple machine" in their construction.

Step 6: Tell students that they should begin the project with a design phase. You may want to spend several class periods on this stage. Ask students to work together to draw a diagram for how their can crusher would work. Have them make a list of all of the items they will need for their machine. Make sure these items are already in the classroom or can be brought from home. Ask students to write instructions for how they will build their can crusher. Encourage them to take measurements and be as detailed as possible.

Step 7: Review each group's designs carefully to ensure they are reasonable given the materials required and time frame of the assignment. Ask each group to explain to you how their machine will work.

Step 8: Conduct a safety lesson regarding the appropriate use of the tools. Ask students to use caution and remember that the tools are not toys.

Step 9: Under close adult supervision (you might need adult volunteers to help), ask students to begin the construction phase. It may take several class periods for students to complete their can crushers. Have students follow their directions carefully and encourage them to ask questions throughout the process.

Step 10: Once all of the machines are constructed, tell students that it is time to test them. Ask each group of students to demonstrate to the class how their can crusher works. Allow other students to ask questions.

Assessment

1. Ask students to explain why it is important for recycling facilities to crush the aluminum cans.
2. Ask students why it is important to develop a detailed design first rather than immediately building a machine.
3. Have students explain why it is important to test the machine.
4. Have students explain how the machine makes crushing cans easier than doing it by hand.

After everyone has demonstrated their crushers, have each student rank each project on a scale of 1 to 10 for each of several categories, such as: total cost of materials, ease of use, efficiency, size, safety, effectiveness, time to construct, etc.

Enrichment

1. Organize a recycling drive for aluminum cans at your school. The can crusher contest can be used to draw attention to the drive. The can crushers designed by the students can be used to help store the cans more easily before they are taken to a recycling center.
2. Invite a local recycling coordinator or recycling professional to your class to talk with students about what he or she does. Ask the visitor to bring in pictures of baled, crushed recyclables as well as samples of recycled products, if possible.

Let's Go Eco-Shopping!

Objective

To teach students how to identify and evaluate environmental attributes of products and assess their environmental impacts.

Activity Description

Research school supplies and determine which products have the most positive environmental attributes.

Materials Needed

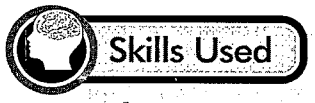
- Five products with environmental claims on labels (such as a cereal box made with recycled content or an aluminum can with a recyclable symbol)
- Index cards or small pieces of cardboard (approximately five)
- *Product Review Worksheet* (one for each student)

Key Vocabulary Words

Postconsumer-recovered material content
Life cycle
Environmental attribute

Duration

2 hours



Skills Used

Communication
Research
Observation/classification
Problem solving

Activity

Step 1: Bring in five products with environmental claims and examine them with the class. List the attributes on the chalkboard and discuss them (refer to the Teacher Fact Sheet titled *Buying Recycled* on page 79). For example, many paper products are manufactured with environmental attributes such as those listed in the "Environmental Attributes for Paper" sidebar. Discuss product manufacturing (refer to the Teacher Fact Sheet titled *Products* on page 25) and its potential impact the environment. Discuss how changing some of the practices involved in product manufacturing can increase or diminish a product's environmental impact.

Environmental Attributes for Paper

Preconsumer content
Postconsumer content
Recyclability of packaging
Recyclability of product
Reusability of item

Step 2: Divide students into groups of approximately five students.

Journal Activity

Have students pretend they are in charge of buying school supplies for their school. Ask them what kinds of environmental attributes they would consider when purchasing supplies.

Step 3: Assign each group one school supply product that could possess environmental attributes (e.g., binders with recovered-content plastic coating, paper clips with recovered plastic, and pencils with recovered-content wood).

Step 4: Have each student in each group visit a store individually and research his or her assigned product. Give students copies of the *Product Review Worksheet* and instruct them to answer the questions while visiting the store.

Step 5: After visiting stores, have students regroup to discuss the results. Each group should pick one brand that they think represents the most environmentally sound product. Let students have their own group discussions and then conduct a class discussion. Start the discussion by writing each group product on the chalkboard. Under each product, list the associated environmental attributes each group discovered. Discuss each attribute, concentrating on what attributes are most important and why. Have the students number the attributes in order of importance, starting with number 1 as the most important attribute.

Step 6: Have students break into their smaller groups again to revisit their choice of the most environmentally sound product. Have the students use the environmental attribute information on the board to answer the following question: Do you think the product you initially chose is still the most environmentally sound product? If not, have them review their product research again and choose the most environmentally sound product.

Step 7: If possible, purchase each of the products the groups decided are most environmentally sound. This should end up involving between five and seven products total.

Step 8: Take the new products with environmental attributes and create a display either in the classroom or elsewhere in the school. Let students get creative with display ideas (e.g., place them on a cloth, include inflatable beachball globes or other environmental symbols). Place an index card or small piece of posterboard next to each product explaining the environmental attributes it contains. Also create a title poster that explains the contents and purpose of your display. Each student could sign the title poster to show his or her participation in the project.

Assessment

1. Ask students to think about their shopping habits. Before today's lesson, ask them if they consider environmental attributes when purchasing products. Ask them if they will in the future. Have them list what kinds of attributes they will pay the most attention to.
2. List a few environmental attributes on the chalkboard and ask students to identify the most important and explain its importance.
3. Ask students to suggest environmental attributes to consider when purchasing some products other than those already researched (e.g., beverages, paint, food items).

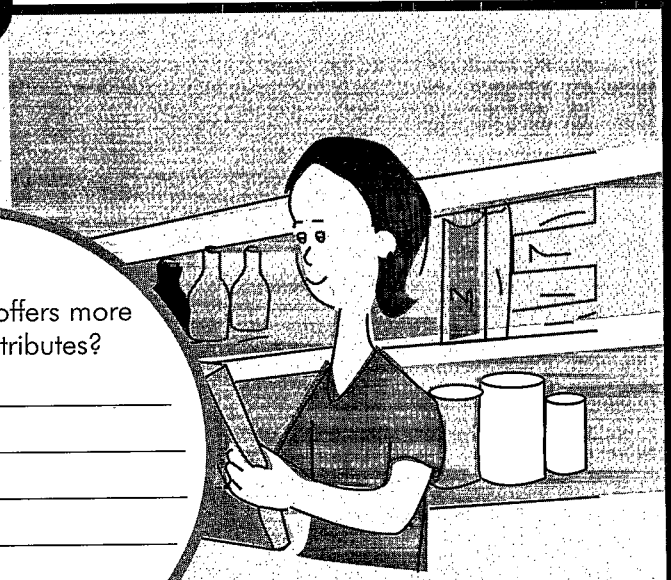
Enrichment

1. Discuss product lifecycle stages: manufacturing, use, and disposal (refer to the Teacher Fact Sheet titled *Products* on page 25) with students. Assign students to select one of the products examined in this activity and draw a colorful flow chart of the steps involved in manufacturing, use, or disposal of the item.
2. Have students write and perform a 30-second advertising spot for a product with environmental attributes. If equipment is available, record each spot on videotape. Discuss how and why each advertisement was or was not effective.
3. Have students write and design a marketing brochure that emphasizes a product's environmental attributes. Instruct students to develop the brochure targeting consumers. The brochures should explain why a consumer might purchase this item over a competing company's product.
4. Pretend that students have been selected to run a new company that evaluates marketing claims on environmental attributes and rates the environmental impact of different products. Have students suggest appropriate names for the company and vote to choose one. Break students into groups of approximately five students and give each group a piece of paper and art supplies (crayons, paint, markers, etc.). Instruct them to design a symbol or logo to represent each environmental attribute their company's products possess. This symbol will be appear on product packaging to advertise the company's environmental awareness. Again, the class can vote on its favorite symbol of an environmental attribute.
5. When visiting stores, have students record the cost of products with and without environmental attributes. Have students evaluate their research and perform a cost comparison.
6. Using the actual product, have students present their product research to the class by acting out a shopping experience in a skit. Tell students to be creative in role-playing. The group does not need to be one big family on a shopping trip. They can role play anyone—a store clerk, another customer, a representative of the company that manufactures the product, even the President of the United States. Instruct students to discuss the environmental attributes of products and practice comparison shopping in the skits.

Student Handout

Name: _____

Product Review Worksheet



1. Are there any brands of your product that advertise environmental attribute claims? If so, how many different brands are available?

_____

2. Which brand offers more environmental attributes?

_____

3. What attributes do you think are the most important and which products have those attributes?

_____

4. After reviewing all of the brands, which one would you purchase and why?

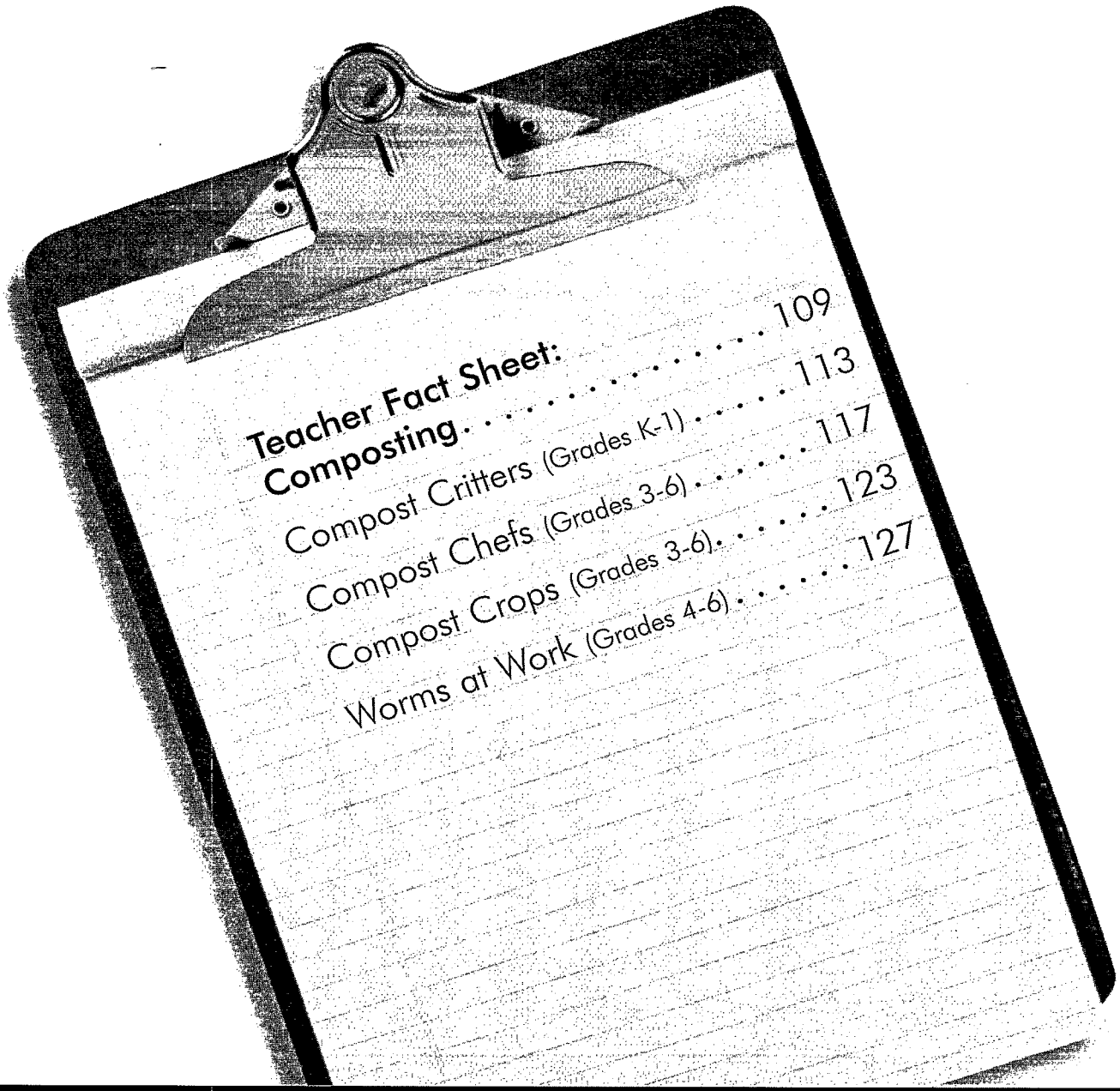
_____

5. What are the costs of the different brands?

_____

CHAPTER 2

Composting



Teacher Fact Sheet: Composting 109

Compost Critters (Grades K-1) 113

Compost Chefs (Grades 3-6) 117

Compost Crops (Grades 3-6) 123

Worms at Work (Grades 4-6) 127

Grade • Subject • Skills Index

Activity Name	Compost Critters	Compost Chefs	Compost Crops	Worms at Work
Grade Range				
K	✔			
1	✔			
2				
3		✔	✔	
4		✔	✔	✔
5		✔	✔	✔
6		✔	✔	✔
Subjects Covered				
Math			✔	
Science	✔	✔	✔	✔
Language Arts				
Social Studies				
Art				
Health				
Skills Used*				
Communication				
Reading				
Research				
Computation		✔	✔	✔
Observation/ Classification	✔	✔	✔	✔
Problem Solving				
Motor Skills	✔	✔	✔	✔

*See Glossary of Skills for more details.

Composting

What Is Composting?

Composting is the controlled **thermophilic** (130°-150°F) **decomposition** of organic materials such as leaves, grass, and food scraps by various organisms. Composting can be divided into three types: backyard, or home, composting; vermicomposting; and heat-based composting.

Home composting is the natural degradation of yard trimmings, food scraps, wood ashes, shredded paper, coffee grounds, and other household organic waste by naturally occurring microscopic organisms. **Vermicomposting** is the natural degradation of similar household organic waste using naturally occurring microscopic organisms and the digestive process of earthworms. Heat-based composting is performed by municipal or commercial facilities that increase the rate of degradation using high temperatures.

Varying amounts of heat, water, air, and food produce different qualities of compost as a final product. Heat-based compost differs from compost produced at ambient temperatures (e.g., a forest floor or home composting) because high temperatures destroy both weed seeds and pathogens. Composts produced by all three systems are crumbly, earthy-smelling, soil-like materials with a variety of beneficial organisms.

Key Points

- Composting is the controlled decomposition of organic materials.
- Composting helps divert a large portion of America's organic trash from landfills and combustion facilities.
- There are three methods of composting: home or backyard composting, vermicomposting, and heat-based composting.
- Invertebrates and microorganisms in compost are key to the breakdown of the organic materials into a rich soil-like product.
- Quality compost is the result of the proper mixture of carbon and nitrogen sources and adequate amounts of moisture, oxygen, and time. Certain food items should be avoided when home composting.
- Compost is a valuable product that can be used as a soil amendment, mulch, or even to decontaminate natural habitats, storm water, and brownfields.
- More than 75 percent of the waste produced in the United States (including paper) is compostable material.

Worms—A Composter's Best Friend

Vermicomposting is a method of composting using a special kind of earthworm known as a red wiggler (*Elsenia fetida*), which eats its weight in organic matter each day. Vermicomposting is typically done in a covered container with a bedding of dirt, newspaper, or leaves. Food scraps (without added fats) can then be added as food for the worms. Over time, the food will be replaced with worm droppings, a rich brown matter that is an excellent natural plant food. Vermicomposting requires less space than normal composting methods, and is therefore ideal for classrooms, apartments, and those in high-density urban areas.

Composting in Action

An easy way to understand all the factors that go into composting is with a hands-on demonstration. A school can provide the perfect medium for these demonstrations. Classes could start a composting bin using food scraps from the cafeteria and yard trimmings from ground maintenance. Depending on the scope of the project, the compost could then be sold to the community in addition to being used on the school campus. Tour a local composting facility, if composting cannot be done at school. For more information on how to start a school composting project, go to the Cornell University composting Web site at <www.cfe.cornell.edu/compost/schools.html> or use these suggested activities to get you started:

- Start a compost pile or bin in the school or as a class experiment.
- Try using compost in place of chemical fertilizers, pesticides, and fungicides. Use compost made by the school or buy it from municipalities or private companies.

The decomposition of organic materials in composting involves both physical and chemical processes. During decomposition, organic materials are broken down through the activities and appetites of bacteria, fungi, and various invertebrates that will naturally appear in compost, such as mites, millipedes, beetles, sowbugs, earwigs, earthworms, slugs, and snails. These insects and microorganisms found in decomposing matter need adequate moisture and oxygen to degrade the organic materials in the most efficient manner.

How Does Composting Work?

Compost contains both carbon and nitrogen sources, which can be simplified as browns (e.g., leaves, straw, woody materials) and greens (e.g., grass and food scraps), respectively. Adequate sources of carbon and nitrogen are important for microorganism growth and energy. The ideal ratio is 30 parts brown to 1 part green. Odor and other problems can occur if the ratio or any of the factors discussed below are not right.

The browns and greens can be mixed together to form compost in a backyard bin or in a municipal compost facility. Whether the composting is done on a small scale or large, the composting process is the same. To encourage decomposition throughout the pile, the compost should be kept moist and turned periodically.

What Are the Benefits of Composting?

As a method of handling the large amount of organic waste created in the United States each day, composting makes good environmental sense. Instead of throwing organic materials away, they can be turned into a useful resource.

In addition, many organic wastes are not ideally suited for disposal in combustion facilities or landfills. Food scraps and yard trimmings tend to make inferior fuel for combustors because of their high moisture content. Decomposition of organic wastes in landfills can create methane, a greenhouse gas that is environmentally harmful because it destroys atmospheric ozone.

Because yard trimmings and food scraps make up about 23 percent of the waste U.S. households generate (EPA, 1998), backyard or home composting can greatly reduce the amount of

waste that ends up in landfills or combustors. In addition, compost is a valuable product that can be used as a soil additive for backyard gardens and farm lands or in highway beautification and other landscape projects.

The benefits don't end there—composting also makes good economic sense. Composting can reduce a community's solid waste transportation, disposal, and processing costs. In many communities, residents pay for each bag or can of trash they put out for pickup. If a household is composting, it will most likely put less in trash cans and will pay a smaller trash bill.

Compost can improve the soil structure of home gardens and farm lands alike by enhancing the soil's capacity to hold moisture and nutrients. This can reduce the need to purchase chemical fertilizers. Adding compost to soil attracts earthworms, which aerate the soil and add additional nutrients. When used as mulch, compost can help prevent erosion by improving soil structure, promoting vegetative growth, and slowing water runoff. Applying compost to soils reduces the likelihood of plant diseases. This is due to the beneficial microorganisms present in compost, which can kill pathogens in the soil. Compost can also be used to decontaminate natural habitats, storm water, and **brownfields**.

In backyards and on the community level, interest in composting has increased rapidly over the past several years. Yard trimmings programs constitute the large majority of composting operations in the United States. In these programs, community members place their yard trimmings in a separate bag or container at the curb, which is collected and taken to a municipal composting facility. These facilities create large amounts of compost, which, in many cases, is sold back to community members. People can also purchase compost created by private composting companies.

What Are the Challenges Associated With Composting?

Creating quality compost requires the right mix of materials and attention to moisture, particle size, and temperature. Too little moisture will slow the decomposition, but too much can create odor problems. To avoid attracting pests and rodents, composters should monitor the food scraps put in the compost pile. Meat scraps, fats, and oils are difficult items to compost, attract pests, and should be kept away from the compost pile.

While composting increases the rate of natural organic decomposition, it still takes months for compost to mature. If compost is used while it is

What Can Go Into a Composting Bin?

This list is not meant to be all inclusive. Some food products should not be included because they can attract pests or compromise the quality of the compost.

Materials to Include	Materials to Exclude
Fruit and vegetable scraps	Meats
Tea bags	Dairy foods
Wool and cotton rags	Bones
Coffee grounds with filters	Fats
Grass/Yard clippings	Pet excrement
Leaves	Diseased plants
Egg shells	Grease
Sawdust	Oils (including peanut butter and mayonnaise)
Fireplace ash	
Nonrecyclable paper	
Vacuum cleaner lint	
Fish scraps	

still "cooking," the high temperatures could kill the plant life on which it is spread. In addition, using compost before it is ready can encourage weed growth because the high temperatures of the pile have not had a chance to kill any potential weed seeds.

What Are Some Emerging Trends in Composting?

A large amount of organic waste is created by institutions, restaurants, and grocery stores—perfect for compost. Across the country, many of these businesses are participating in pilot projects to compost their food scraps and soiled paper products. These businesses can not only provide a valuable component of compost—organic material—but also can reduce their waste disposal costs significantly.

Compost is also being used as an innovative technology to clean up land contaminated by hazardous wastes, remove contaminants from storm water, facilitate reforestation, and restore wetlands and other natural habitats. Compost has been used to restore soil that is contaminated with explosives, munitions wastes, petroleum, fuel wastes, and lead and other metals. In addition, various biodegradable tableware and dishes are being tested for compostability.

Additional Information Resources:

Visit the following Web sites for more information on composting and solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA, Office of Solid Waste site on composting: <www.epa.gov/compost>
- Cornell University composting site: <www.cals.cornell.edu/dept/compost/composting_homepage.html>
- U.S. Composting Council Web site: <www.compostingcouncil.org>

To order the following additional documents on municipal solid waste and composting, call EPA toll-free at 800 424-9346 (TDD 800 553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *Environmental Fact Sheet—Yard Waste Composting* (EPA530-SW-91-009)
- *Innovative Uses of Compost Erosion Control, Turf Remediation, and Landscaping* (EPA530-F-97-043)
- *A Collection of Solid Waste Resources*—CD-ROM (EPA530-C-98-001)

Compost Critters

Science

Objective

To teach students that nature can "recycle" its own resources.

Activity Description

Students will search for and observe some of nature's recyclers at work, learning what role each plant or animal plays in the recycling process.

Materials Needed

- An outdoor area, such as a yard, park, or garden, that offers access to some of the following: rocks, trees (dead and living), leaf litter, mushrooms
- One or two teacher's aides or parents to help facilitate the outdoor adventure (optional)
- Several sheets of drawing paper and pencils or crayons per student
- One clear viewing container with holes

Key Vocabulary Words

Decay
Mushroom
Millipede
Fungi
Lichen

Duration

Outdoor expedition:
1 hour
In-class follow-up:
30 minutes

Skills Used

Observation/classification
Motor skills

Activity

Step 1: Visit your chosen outdoor area prior to the class trip in order to make sure it is suitable for viewing nature's recyclers. Scout out four specific "stations" for the students to visit, including a live tree, an old decomposing log, a large rock (or board) in the soil, and a leaf-covered patch of soil. To draw insects to a specific spot, you might want to plant a log or board in the soil several days in advance.

Step 2: Discuss recycling with the students and explain the following concepts (refer to the Teacher Fact Sheet titled *Composting* on page 109 for background information):

- Why we recycle and why nature also needs to recapture the value of its organic waste.
- What kinds of "trash" get "recycled" in nature.
- Who recycles these materials. Discuss the plants and animals, such as snails, slugs, beetles, millipedes, earthworms, fungi, pillbugs, snowbugs, mushrooms, and lichen that perform nature's recycling work.

Step 3: Divide the class into small groups of three to four students. Explain that the students are now adventurers on a mission to locate and study nature's recyclers at work. Remind students that it's very important to observe, but not touch or disturb the recyclers or their habitat.

Step 4: Lead the students to your predetermined outdoor area and stop at each of the four stations. At each station, first lead a discussion (see below) and then give each group

of students the chance to get up close and make individual observations. A list of suggested topics and discussion questions for each station follows:

Station #1–Live Tree

- Ask students what makes the tree grow. Where are its roots? Where does it get its food from?
- Will the tree live forever?
- Are its leaves falling to the ground?

Station #2–Dead, Decaying Log

- Ask students how this tree is different from the live one.
- Have them touch and smell its bark. How is it different than the live bark? Is it dry or damp?
- Do the students see evidence of the wood being eaten? By what?
- Have the students look in the crevices and cracks for any of nature's recyclers at work. If they see ants, spiders, millipedes, mushrooms, etc., ask them the following questions:
  - — Is it a plant or animal?
  - — What's its name?
  - — How does it move? How many legs does it have?
  - — What color is it?
  - — Why is it living under this dead log? What does it eat?
  - — How many of these creatures are living together?
- If it's possible (and safe), capture a few of these recyclers in your clear container and let the students view them up close. You may want to impose an item limit to prevent too much disruption for the critters. Students could draw the recyclers they see in nature or wait until they return to the classroom and draw from memory. Make a point of returning the creatures safely to their homes after the viewing is over.

Station #3–Large Rock or Board

- Have the students watch as you carefully lift the rock from its position. Ask students to look at what's underneath it.
- What's it like under the rock? Is it dark and moist?
- Can the students see any of nature's recyclers at work here? If they do see life, ask them the same questions as above:
  - — Is it a plant or animal?
  - — What's its name?
  - — How does it move? How many legs does it have?
  - — What color is it?
  - — Why is it living under this rock or board? What does it eat?
  - — How many of these creatures are living together?

Station #4–Leaf Litter and Soil

- Have the students use their hands to dig through the leaves and into the soil.
- Ask them to compare these leaves to the leaves still on the live tree. How are they different? Are these leaves older? Are they wet or dry?
- Have the students look for evidence of nature's recyclers; again, identify and discuss any animals or plants that they find.
- Ask the students to feel and smell the soil. How does it compare to the dead log they visited earlier?

Step 5: Before returning to the classroom, visit the live tree station again. Ask students to think again about where this tree gets its food. Discuss how the decaying log, busy creatures, and moist, rich soil all play a role in keeping the tree alive.

Assessment

1. Back in the classroom, pass out paper and colored pencils or crayons to the students. Have each student draw one of the recyclers he or she saw outside. Ask each student to verbally describe to the class how this creature moves, what it's called, and what recycling role it plays in nature.
2. Ask the students how they are like nature's recyclers. Do they recycle anything at home? How does it get reused?
3. Have the students draw a tree in different stages of its life, showing the tree 1) budding, 2) in full growth, 3) with leaves falling, 4) as a dead tree, having fallen as a log and decaying back into the earth, and 5) as a new tree growing from the soil.

Enrichment

1. Engage students in a role-playing activity. Have students pretend that they are different recyclers (ants, millipedes, worms, mushrooms, spiders). Ask the students how these animals or plants moved or behaved. Have the students imitate this behavior.
2. Study nature's recyclers in the winter by collecting some leaf litter, bringing it inside, and warming it with a lamp. Dormant recyclers, such as millipedes, ants, spiders, and worms will come to life under the heat.
3. Conduct another nature walk, this time giving each student a recyclable paper bag. Have them collect dead leaves, sticks, nuts, or other teacher-approved items on their walk. When students return to the classroom, discuss what role these items have in nature and in the natural cycle of life. Is the item dead or alive, what is it called, is there any evidence of nature's recyclers at work? Help them glue or tape these items on a piece of construction paper and display them. Have the students perform leaf rubbings by placing a leaf under a piece of paper and coloring over it to reveal its shape and texture. Ask the students to explore how each leaf is similar or different from others.

Compost Chefs

Science

Objective

To teach students how composting can prevent food scraps and yard trimmings from being thrown away and how different components, such as air, moisture, and nitrogen, affect composting.

Activity Description

Students will create four compost bins that differ in their amounts of air, moisture, and nitrogen. Students will observe and record the differences these conditions cause in the composting process.

Materials Needed

- Four thin, plastic buckets (5 gallons each) or other plastic container (e.g., milk jug)
- One hand drill or punch-type can opener
- One copy of the *Compost Chef* worksheet per student
- Grass clippings (shredded, if possible)
- Vegetable and fruit peels
- Weeds (shredded, if possible)
- Hay (shredded, if possible)
- Sawdust
- Coffee grinds
- Thermometer
- Bloodmeal
- One marker or pen
- Tape
- Four pieces of construction paper (3 by 5 inches each)
- Garden trowel

Key Vocabulary Words

Compost
Nitrogen
Oxygen
Decompose
Bedding
Organic

Duration

Set-up: 1 hour

Follow-up: 15 minutes to 1 hour on an occasional basis for up to 4 weeks

Skills Used

Computation
Observation/classification
Motor skills

Activity

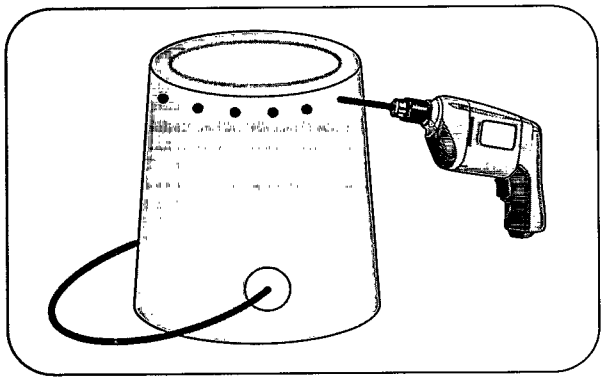
Step 1: Photocopy and distribute one copy of the *Compost Chef* worksheet to each student. Introduce the following concepts (refer to Teacher Fact Sheet titled *Composting* on page 109 for background information):

- Explain to the class what compost is and how it is made.
- Discuss why composting is important in managing and reducing trash that is sent to landfills.
- Explain how composting works, and how nitrogen, oxygen, and water all play a part in the creation of compost.

Journal Activity

Ask students to pretend they are gardeners. Ask them if they would use compost to help their gardens grow. Why or why not?

Step 2: Pick an appropriate project space. This activity can either be conducted in an indoor area of the classroom that has been covered with a protective drop cloth or in a designated area outside of the school. If you choose to leave the compost buckets outside, make sure the chosen area will not be disturbed by recess or after-school activity. Use the hand drill and carefully poke several holes in the sides (near the bottom) of three of the buckets or milk jugs.



Step 3: Have the students sit in a circle within view of you and the compost buckets. Divide the class into four groups and assign a group of students to each bucket. Using the construction paper and marker, label the buckets "one" through "four."

Step 4: Work with each group of students to set up the buckets. As each mixture is created, discuss its ingredients and ask students to record the "recipe" on their *Compost Chef* worksheets. Following are directions for setting up each bucket:

Bucket #1–Compost lacking nitrogen.

- Place mostly "brown" carbon-containing materials in the bucket, such as dead leaves, straw, and coffee grounds. On top, add a few vegetable and fruit peels.
- Moisten, but do not soak, the mixture with water.

Bucket #2–Compost lacking moisture.

- Place a mixture of "green" grass clippings (make sure they are dry), bloodmeal, and vegetable and fruit peels in the bucket.
- Place a few layers of "brown" dead leaves, straw, and coffee grounds into the mixture.
- Do not add any water.

Bucket #3–Compost lacking air circulation.

- Use the bucket without the holes.
- Place several layers of mostly high-nitrogen grass clippings, bloodmeal, vegetable peels, and fruit peels in the bucket.
- Moisten the mixture with water.

Bucket #4–"Perfect" Compost.

- Layer (in an alternating pattern) leaves, coffee grounds, straw, and vegetable and fruit peels, and a small amount of grass clippings in the bucket.
- Moisten the mixture with water.

Step 5: Explain that, as compost chefs, the students must monitor their creations. Give each group written instructions on how to care for its compost bucket over the next few weeks. For example:

Bucket #1

- Use a garden trowel to stir your compost mixture regularly: once every 3 days for the first 2 weeks, then once per week.
- Add a dash of moisture to your compost mixture with a sprinkle of water every other week.

Bucket #2

- Use the garden trowel to stir your compost mixture regularly: once every 3 days for the first 2 weeks, then once per week.
- Keep your compost mixture dry.

Bucket #3

- Add a sprinkle of water to your compost mixture every week.
- Make sure you don't stir your mixture.

Bucket #4

- Add a sprinkle of water to your compost mixture every week.
- Use the garden trowel to stir your mixture regularly: once every 3 days for the first 2 weeks, then once per week.

Step 6: At each interval of stirring or watering, have all of the groups visit each compost bucket and record their findings, including temperature, appearance, and smell. Students can use their *Compost Chef* worksheets for this task.

Step 7: After 4 weeks, have the students use the trowels to dig into each compost pile and examine it closely. Ask them to compare and contrast the compost in each bucket. Ask students which mixture decomposed the most.

Step 8: Use the finished compost from Bucket #4 as soil for classroom plants or a garden. Have students explore how compost aids new vegetative growth.

Assessment

1. Ask students to list the most important ingredients for a good compost pile (nitrogen, water, and air circulation). Have them explain what role each ingredient plays in decomposition. Ask each group to name the missing ingredient in its mixture (Group #4 won't have a missing ingredient).
2. Have the students explain how composting reduces the amount of waste that we send to landfills.
3. Ask students to think of places in nature where composting might occur naturally.

Enrichment

1. Collect and evaluate the data on each student's *Compost Chef* worksheet. Have the students create charts or graphs based on the temperature data they collected. Which pile had the highest mean temperature? What does a high temperature mean in terms of decomposition?
2. Explore composting as a natural cycle. Study the nitrogen cycle and have students make diagrams of its components. (The nitrogen cycle is the continuous cyclic progression of chemical reactions in which atmospheric nitrogen is compounded, dissolved in rain, deposited in soil, assimilated, and metabolized.) Use composting as a lead-in to discuss other natural cycles.
3. Start a schoolwide compost bin using the appropriate wastes from school lunches. Have students decide which wastes can be added to the pile and have different classes watch over and stir the pile each week. Have each participating class start a small flower garden plot, using the compost as a soil amendment.

Student Handout

Compost Chef

Name: _____

Week 1
Temperature:
Appearance:
Smell:

Week 2
Temperature:
Appearance:
Smell:

Week 3
Temperature:
Appearance:
Smell:

Week 4
Temperature:
Appearance:
Smell:

Bucket #1

Ingredients:

Week 1
Temperature:
Appearance:
Smell:

Week 2
Temperature:
Appearance:
Smell:

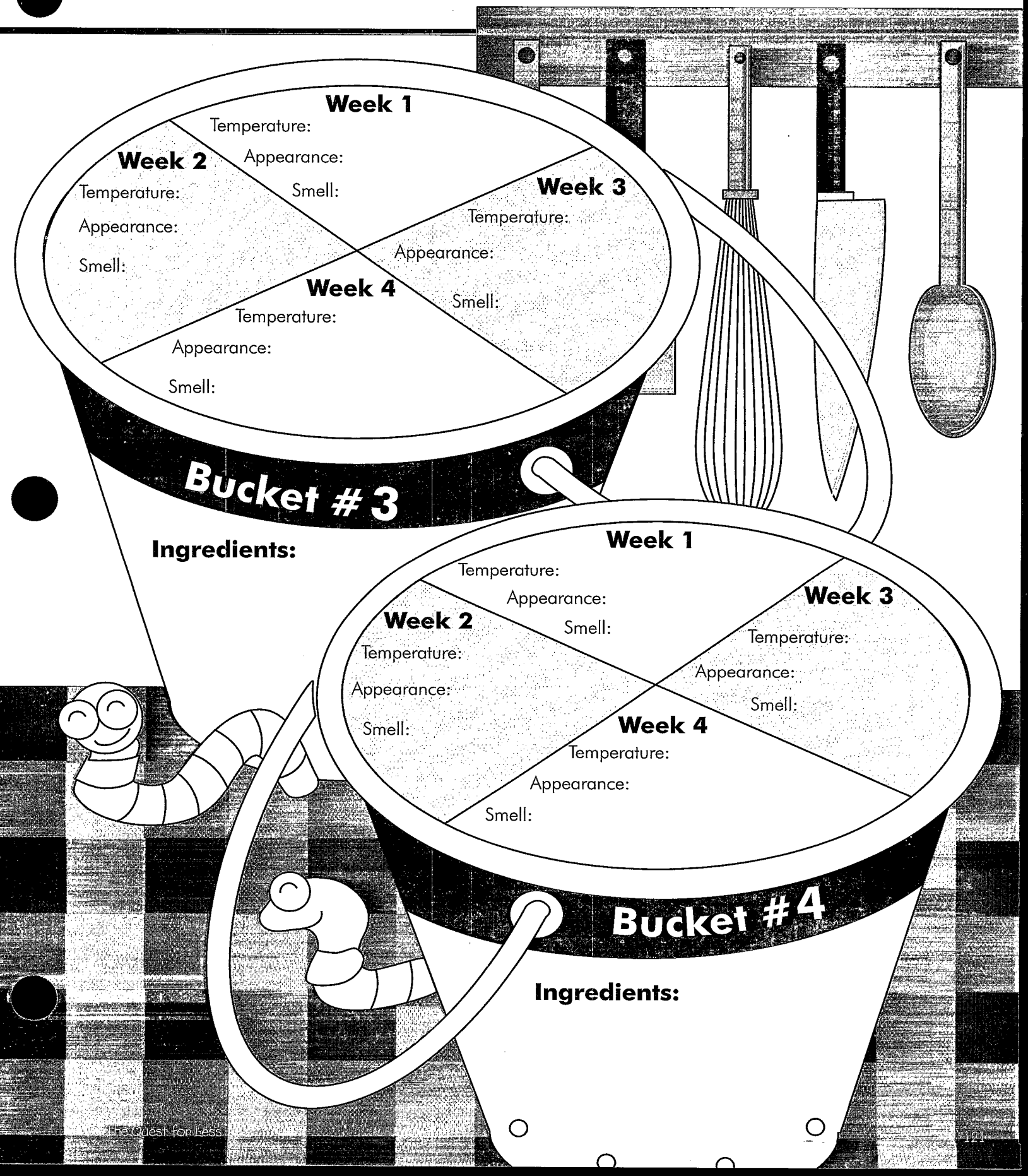
Week 3
Temperature:
Appearance:
Smell:

Week 4
Temperature:
Appearance:
Smell:

Bucket #2

Ingredients:

Student Handout



Compost Crops

Prerequisite: This activity involves the use of previously made compost. Your students can use the compost they made from completing one of the following activities: Compost Chefs or Worms at Work.

Objective

To teach students how composting can prevent food scraps and yard trimmings from being thrown away and to show them the usefulness of compost in gardening.

Key Vocabulary Words

- Decompose
- Compost
- Root
- Nutrient

Activity Description

Students will assess the effectiveness of compost as a soil amendment by planting and comparing two garden plots—one that relies just on dirt and one that relies on their homemade compost.

Duration

- Setup: 1 hour
- Follow-up each week: 15 minutes

Materials Needed

- *Compost* (See prerequisite above)
- Two 4- by 4-foot garden plots in the schoolyard
- Two packets of flower seeds (have your students vote on the type and color)
- Two seed packets of a vegetable that grows well in your locale
- One watering can
- Two garden trowels
- One copy of the *Compost Crop* worksheet per student
- One tape measure or ruler

Skills Used

- Computation
- Observation/classification
- Motor skills

Activity

Step 1: Locate and mark the two schoolyard garden plots you plan to use, making sure they receive plenty of direct sunlight. Secure permission for gardening from the proper school authorities.

Step 2: Discuss composting with the students and explain the following concepts (refer to the Teacher Fact Sheet titled *Composting* on page 109 for background information):

- Recap how the students made the compost and what materials they used.
- Discuss how this compost can now be used in a garden.
- Explain why compost can be more effective than just natural soil.

Step 3: Take the class outside to the garden plots and divide the students into two groups. Explain how the composting experiment will work. Tell one group that they will only add water to the soil to help their plants grow. Give the other group a bucket of compost and tell them to use the trowels to mix it into their soil before watering it.

Journal Activity

Ask students to pretend they are world-famous gardeners giving an interview about the secrets of their success. How do they make their plants grow so well?

Step 4: Have each group plant flower seeds and vegetable seeds according to packet instructions in their respective plots.

Step 5: Ask the students to predict which plot will grow better and faster. Have them record their predictions and reasoning on their *Compost Crop* worksheets.

Step 6: Break each of the two groups into pairs of students and assign each pair a week during which they are gardeners. During that week, those students are responsible for visiting their group's plot each day. They should water it and use the tape measure or ruler to record any changes in plant growth on their *Compost Crop* worksheets. Create a gardener calendar for the classroom to remind students when it's their turn to watch over the plots.

Step 7: After 4 or 5 weeks, have the entire class visit the garden plots again. Discuss which plot's plants grew faster. Ask student volunteers to gently dig up one plant from each plot. Have the students examine and compare the root structures of each plant. Have several students dig around in the plots' soil, discuss the differences in texture or moisture they find, and have them notice how many earthworms or bugs they find.

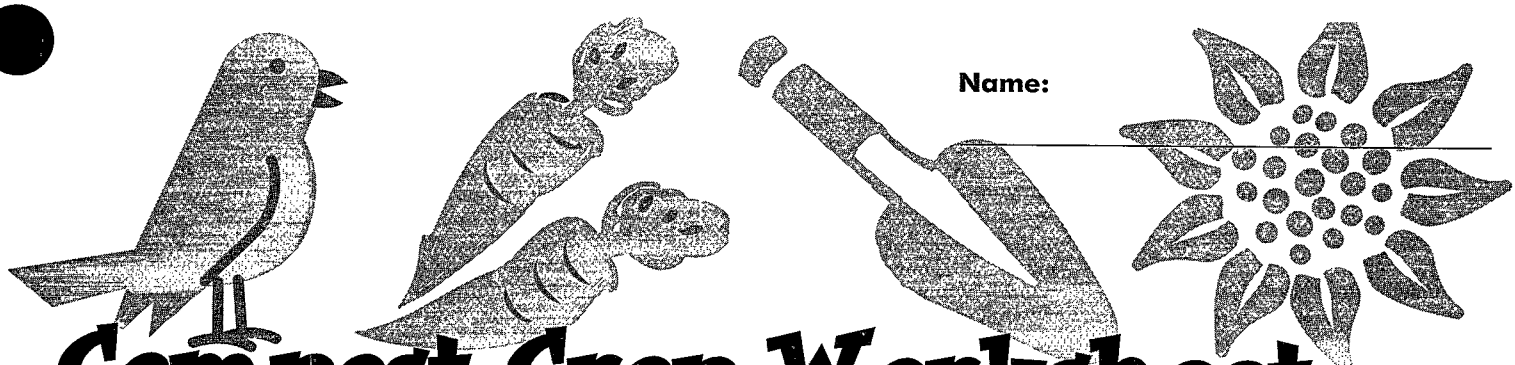
Step 8: If the vegetables in the plot are ripe, pick them and have a class snack from the compost harvest.

Assessment

1. Have students list the benefits of composting, both from the standpoint of preventing waste and as a garden soil supplement.

Enrichment

1. Use the two garden plots as a lead-in to a more in-depth science lesson on soil and compost. Compare the relative amounts of materials in different soil samples. Have student volunteers collect a handful of soil from each plot. For each sample, fill a liter (or quart) jar about one-quarter full of soil, then add water to about the three-quarter level. Screw the lid on tightly and shake hard for about a minute. Let the jars stand for several minutes. The mixture will separate into layers, with the largest particles (gravel and sand) settling on the bottom, and finer particles (clay and silt) settling above. Organic matter—leaves, twigs, and any animal matter—will float on top of the water. Discuss the differences between the soil and compost/soil plot samples. Explore the components of your local soil and compost.
2. Have the students compile their measurements and recordings from their *Compost Crop* worksheets on the board. Depending on the age group, ask all of the students to make graphs charting the growth in each plot. Ask them why plants in the compost plot grew more quickly.
3. Discuss the root structures of the plants from the different plots. Ask students if the plant from the compost plot was more developed in its root structure? Why?
4. Ask the students to think about the differences in the soil of the two plots. Did they see more earthworms in the compost plot? Why? Why would these creatures be attracted by the compost? How did the presence of earthworms affect the growth of the plants?
5. Start a schoolwide compost bin using the appropriate wastes from school lunches. Have students decide which wastes can be added to the compost pile and have different classes watch over and stir the pile each week. Have each participating class start a small flower garden plot, using the compost as a soil amendment.



Name: _____

Compost Crop Worksheet

Plot #	Amount of Water Added	Soil Status (How It Looks and Smells)	Presence of Plant Growth? Which Plants?	Measurement of Plant Growth (mm)	Thoughts or Observations
Day 1					
Plot #1 (just soil)					
Plot #2 (compost and soil)					
Day 2					
Plot #1 (just soil)					
Plot #2 (compost and soil)					
Day 3					
Plot #1 (just soil)					
Plot #2 (compost and soil)					
Day 4					
Plot #1 (just soil)					
Plot #2 (compost and soil)					
Day 5					
Plot #1 (just soil)					
Plot #2 (compost and soil)					

Worms at Work

Science

Objective

To teach students that food scraps and yard trimmings can be made into compost instead of being thrown away.

Activity Description

Students will create a compost bin using worms and food scraps and monitor changes in the bin over time.

Materials Needed

- Large plastic bin (about 8 to 16 inches deep) with holes in the bottom for aeration
- Tray for underneath the bin
- Two bricks or other large sturdy objects
- 9 to 14 pounds of newspaper
- One bag of potting soil
- 1 pound of red worms
- Food scraps (such as bread, vegetables, fruits, eggshells, grains, coffee grounds, tea bags) Do NOT include meat, bones, mayonnaise, fish, peanut butter, candy, or nonfood items
- Tarp or drop cloth
- Bucket or other carrying container
- Household gloves (optional)
- Copy of *Vermicomposting Data Sheet* for each student

Key Vocabulary Words

Compost
Vermicomposting
Castings
Decompose
Bedding
Organic

Duration

Setup: 1 hour
Follow-up: 15 minutes to 1 hour on an occasional basis

Skills Used

Computation
Observation/classification
Motor skills

Activity

Step 1: Explain to the class what compost is and how it is made (refer to the Teacher Fact Sheet titled *Composting* on page 109). Discuss the use of worms, the need for and use of organic waste, and other vocabulary words. During the course of this lesson, inform students of good and bad foods to use in composting, as well as the reason why it is better to compost than to throw food scraps away.

Step 2: Place bin on top of two bricks and put tray under bin.

Step 3: Have the students tear each sheet of newspaper lengthwise into strips that are 1 to 3 inches wide and place half of the pile in the bin.

Step 4: Have the students multiply the number of pounds of newspaper by 3 to determine the total amount of water needed (a pint of water weighs a pound, and a gallon of water

Journal Activity

Have students write a poem, such as a limerick, that describes what compost looks like and how it feels when touched.

weighs 8 pounds). Then add half of the water to the bin with newspapers.

Step 5: Sprinkle two handfuls of soil and the rest of the newspaper and water. Have the students mix the contents well and distribute evenly in the bin.

Step 6: Gently place the worms on top of the bedding, spreading them evenly. Keep the bin uncovered so the students will see the worms moving down into the bedding to avoid light.

Step 7: Use the attached data sheet to record all activities surrounding the worm bin, including the date the bin was set up, the number of worms (or pounds of worms) added to the bin, and the number of people contributing food scraps (number of people in the class). For the remainder of steps for this activity, have students record the date and day food is added, including the type of food and its weight, as well as the amount of water added. The compost bin should always remain moist.

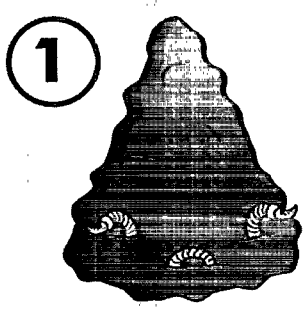
Step 8: Use food scraps that you brought from home or that you asked students to bring from home or save from school lunch, and have students add them to the bin. Food can be added daily, weekly, or monthly. Do not overload the system; bury food relatively evenly amongst the different "plots." On the data sheet, instruct students to keep track of how much food they are providing the worms and where it is placed (see diagram on data sheet).

Step 9: Place a sheet of newspaper over the top of the bin to prevent flies from circulating near the area. Store the bin in a cool place out of direct sunlight, and keep the lid tightly shut.

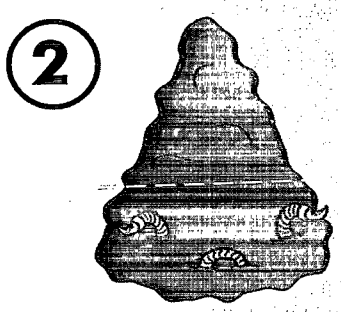
Step 10: Have students check the bin frequently as they add food scraps to see the changes that occur. After a period of 3 to 6 months, depending on the size of the container, most of the food and bedding will be transformed into worm castings, the nutrient-rich waste materials that worms excrete.

Step 11: In order to harvest the compost, or humus, for use (if you choose to), you must change the bedding and temporarily remove the worms. Spread out a tarp or drop cloth in an open area and dump out the entire contents of

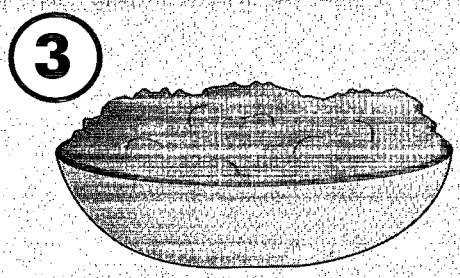
Step 11: How To Harvest Compost



Divide compost materials into several cone-shaped piles (larger on the bottom).



Scoop off the material from the top of the piles.



Put the castings into a container to carry out to the garden.

the bin. Have students help you divide the materials into several cone-shaped piles (larger on the bottom, so the worms will burrow into it and avoid the light). Direct students to scoop off the material from the tops of the piles, and put the castings into a container to carry out to the garden (see illustration on the previous page for help). Repeat this procedure until most of the compost is harvested.

Step 12: Have students put worms back in the bin, along with any uncomposted food and old bedding. Your class can start a new stock of bedding and add in any additional worms to begin the process again.

Step 13: Create a garden in which to use the compost as a soil amendment, or use the compost on the schools' beds or lawn.

NOTE: Other critters may make their way into the compost bin. Many are beneficial, including mold, bacteria, sow bugs, beetle mites, white worms, snails and slugs, flies, round worms, and millipedes. You do NOT want the following in your bin, however: flat worms, ground beetles, centipedes, ants, and pseudo scorpions. If you find any of these organisms, start over.

Assessment

1. Ask students to define and describe decomposition.
2. Ask students why it is beneficial to compost items instead of throwing them away.

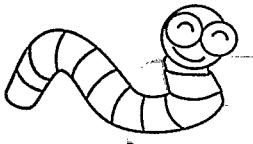
Enrichment

Ask the students to make observations about the worm bin each week. Do smaller pieces of food tend to break down faster than larger ones? What does the compost smell like? What organisms do they notice? Are the worms multiplying?

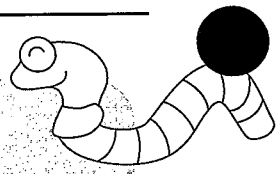
1. Have students take the temperature of the worm bin once a week to determine the variations that occur while food is composted. Use a thermometer that can measure up to 170°F. Have the students create bar graphs showing the increase or decrease in temperature over time.
2. Let students use a pH paper to test the acidity of the worm bin once a week. Does the pH change based on the foods that are added? Have the students keep a record of the foods that are added and the pH and chart a graph showing the correlation. If the soil is too acidic, the worms may try to leave the bin. Try adding a little lime.
3. Give students gloves to gently examine the critters inside the bin once a week. You might also examine a sample of the soil under a microscope (at the beginning of composting, bacteria are present that help break down the food; later larger organisms such as sowbugs and round worms play a larger role.) Obtain an identification guide to invertebrates and insects and see how many you can identify. Have students draw the different kinds of critters and discuss the differences in each (number of legs, body parts, function).

Student Handout

Name: _____



Vermicomposting Data Sheet



Date bin was set up: _____

Number of worms (or pounds of worms) added to bin: _____

Number of people contributing food scraps on a regular basis: _____

Date	Day	Weight of food added	Type of food added	Amount of water added	Buried in site #	Notes

(If you run out of spaces, get an extra copy of this sheet from your teacher.)

On the back of this paper, draw the worm bin, including its dimensions, and assign plots to certain sections so you can track decomposition of food placed in each numbered area.

Harvest date: _____

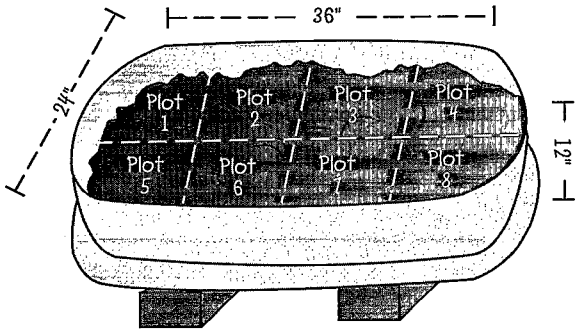
Total days: _____

Total weight of food buried: _____

Weight of uneaten food left over: _____

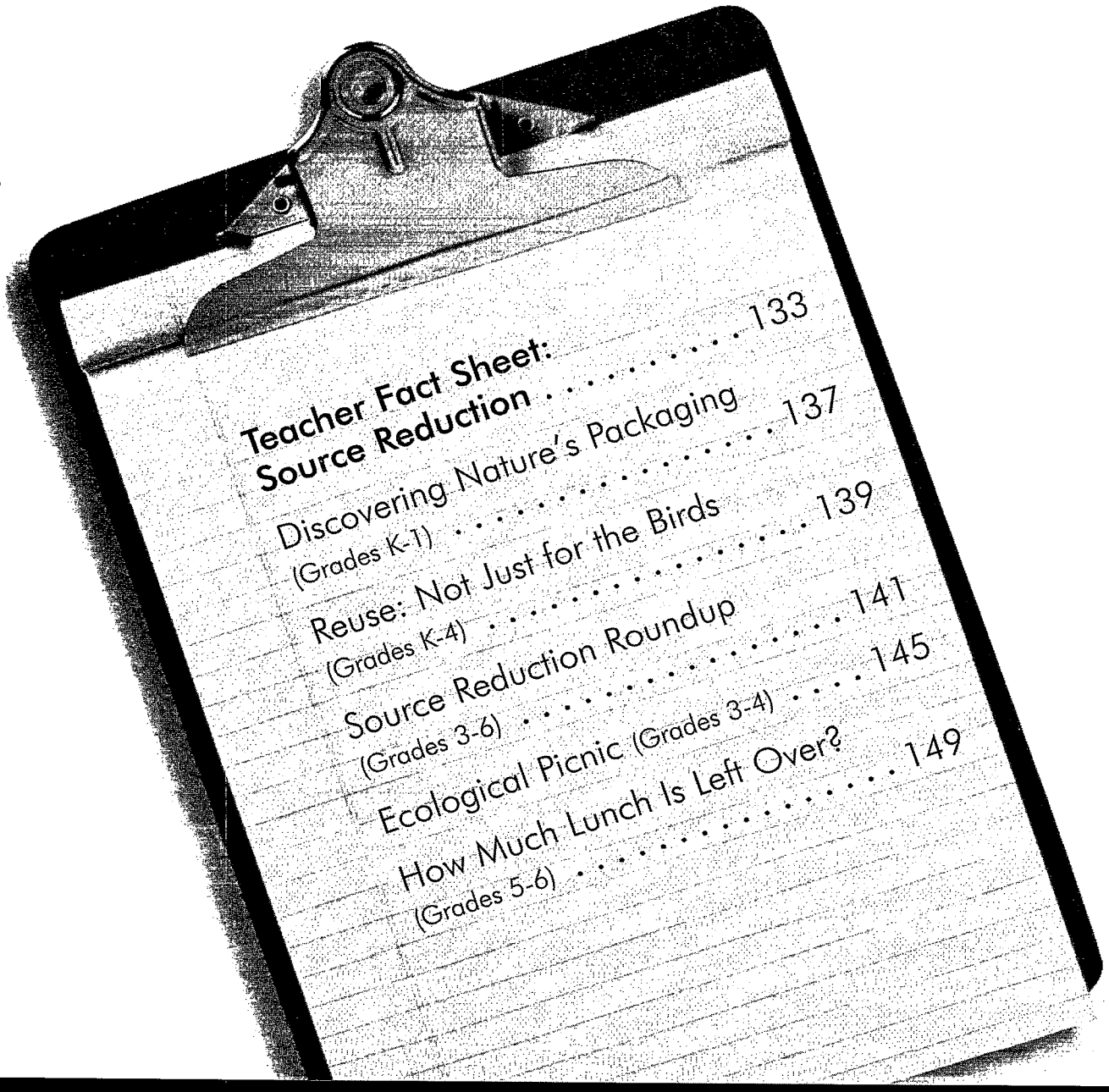
Average weight buried per day: _____

Example:



CHAPTER 3

Source Reduction



Teacher Fact Sheet: Source Reduction 133

Discovering Nature's Packaging (Grades K-1) 137

Reuse: Not Just for the Birds (Grades K-4) 139

Source Reduction Roundup (Grades 3-6) 141

Ecological Picnic (Grades 3-4) 145

How Much Lunch Is Left Over? (Grades 5-6) 149

Grade • Subject • Skills Index

Activity Name	Discovering Nature's Packaging	Reuse: Not Just for the Birds	Source Reduction Roundup	Ecological Picnic	How Much Lunch Is Left Over?
Grade Range					
K	✔	✔			
1	✔	✔			
2		✔			
3		✔	✔	✔	
4		✔	✔	✔	
5			✔		✔
6			✔		✔
Subjects Covered					
Math				✔	✔
Science				✔	✔
Language Arts			✔		
Social Studies				✔	
Art	✔	✔			
Health					
Skills Used*					
Communication			✔	✔	
Reading					
Research					
Computation				✔	✔
Observation/ Classification	✔		✔	✔	
Problem Solving					✔
Motor Skills	✔	✔			

*See Glossary of Skills for more details.

Source Reduction

What Is Source Reduction?

Americans crave convenience—but at what cost? American households have more discretionary income than most households worldwide, spending more on products that create more waste. Over the last 40 years, the amount of waste each person creates has almost doubled from 2.7 to 4.46 pounds per day (that is 1,628 pounds per person per year!). Though reusing, recycling, and composting are all important methods of reducing the amount of waste produced, the most effective way to stop this trend is by preventing the production of materials that could become waste.

Source reduction, also known as **waste prevention,** is the practice of designing, manufacturing, purchasing, or using materials (such as products and packaging) in ways that reduce the amount or toxicity of waste. Source reduction can help reduce waste disposal and handling costs because it avoids the costs of **recycling**, municipal **composting**, **landfilling**, and **combustion**. It also conserves **natural resources** and reduces **pollution**.

Preventing waste before it is generated is a common-sense way to save financial and natural resources, as well as reduce pollution. That is why the U.S. Environmental Protection Agency (EPA) encourages consumers, businesses, and governments to make source reduction their first priority in waste management practices. For waste that cannot be prevented, recycling is the next best choice. (See the Teacher Fact Sheet titled *Recycling* on page 73 for more information on recycling.)

Waste is generated throughout the life cycle of a product—from extracting raw materials, to transporting materials, to processing and manufacturing goods, to using and disposing of products. Manufacturers that reuse materials in the production process or that use less material to manufacture products can decrease waste dramatically. Other ways that manufacturers practice source reduction include:

- Reduce the amount of packaging in the manufacture of items.
- Reduce the amount of toxic components in a product or use smaller quantities of items with high toxicity.
- Reuse parts in the manufacture of a product.
- Redesign products to make them more modular. This allows broken or unusable components to be replaced rather than discarding the entire item.

In addition to reducing the amount of materials in the solid waste stream, reducing waste toxicity by

Key Points

- Source reduction, also known as waste prevention, means reducing waste at the source. It can take many different forms, including reusing or donating items, buying in bulk, reducing packaging, redesigning products, and reducing toxicity.
- Source reduction also is important in manufacturing. Lightweighting of packaging, reuse, and remanufacturing are all becoming more popular business trends. Purchasing products that incorporate these features supports source reduction.
- Source reduction can save natural resources, reduce pollution, reduce the toxicity of our waste, and save money for consumers and businesses alike.
- Incorporating source reduction into daily practices can require some challenging but worthwhile lifestyle changes.

Source Reduction Facts

- Since 1977, the weight of 2-liter plastic soft drink bottles has been reduced from 68 to 51 grams each. That means that 250 million pounds of plastic per year has been prevented from becoming part of the waste stream.
- When McDonald's reduced its napkin size by 1 inch, the company prevented 12 million pounds of paper from being thrown away each year. In 1999, McDonald's switched to lighter weight packaging for two of their sandwiches, conserving 3,200 tons of boxboard containers.
- State Farm Mutual Auto Insurance converted to electronic cameras for their claims processing, saving more than 50 tons of instant and 35mm film.

(Source: EPA, 1996, 1999)

selecting nonhazardous or less hazardous materials for manufacturing is another important component of source reduction. Using less hazardous alternatives for certain items (e.g., cleaning products, pesticides), sharing products that contain hazardous chemicals instead of throwing out leftovers, reading label directions carefully, and using the smallest amount of a chemical necessary are some ways to reduce waste toxicity. (See the Teacher Fact Sheets titled *Solid Waste* on page 41 and *Hazardous Waste* on page 45 for information on safe household hazardous waste practices.)

Source reduction is a challenge requiring creativity and ingenuity, but devising ways to prevent waste can be very satisfying and even fun! There are many ways consumers can practice source reduction. Here are just a few examples:

- Choose products that do not use excessive packaging.
- Buy remanufactured or used items.
- Buy items in bulk rather than multiple, smaller packages to decrease the amount of packaging waste created.
- Maintain and repair durable items.
- Reuse bags, containers, and other similar items.
- Borrow, rent, or share items that are used infrequently.
- Donate items instead of throwing them out.
- Leave grass clippings on the lawn (**grasscycling**) or use them for **backyard composting**.
- Rake fallen leaves for composting rather than bagging them and throwing them away.

As a classroom activity, ask students to provide examples of other creative ways they can reduce waste.

What Are the Benefits of Source Reduction?

Reducing waste at the source is the ultimate environmental benefit. It means waste does not have to be collected, handled, or processed in any way, which prevents pollution, saves energy, and saves money. In addition, by reducing consumption, fewer products are manufactured, thus reducing the impacts that manufacturing can cause. For example, by manufacturing less, **greenhouse gas** emissions are reduced, which can make a difference in preventing **global climate change**.

Preventing waste also can mean economic savings for communities, businesses, schools, and individual consumers. Many communities have instituted "pay-as-you-throw" waste management systems in which people pay for each can or bag of trash they produce that requires dis-

posal. When these households reduce their waste at the source, they create less trash and, consequently, pay a lower trash bill.

Businesses also have an economic incentive to practice source reduction. Manufacturing costs can decrease for businesses that reduce packaging, which can mean a larger profit margin and savings that can be passed on to the consumer.

Schools also can share in the economic benefits of source reduction. Buying products in bulk frequently means a savings in cost. Often, what is good for the environment is good for the pocketbook as well.

What Are the Challenges of Source Reduction?

Practicing source reduction is likely to require some change in daily routines. Changing some habits may be difficult, but the environmental returns on the effort can make it worthwhile. For example, while using disposable utensils might be convenient, using durable flatware saves resources and requires only slightly more effort (for cleaning). On the other hand, if waste is not reduced, the economic and social costs of waste disposal and the environmental impacts throughout the life cycle of products will continue to grow, and it will become increasingly harder to make decisions about waste management.

Even if consumers decide to change their consumption habits, products with minimal packaging and nontoxic ingredients are not always available. Balancing the immediate convenience of easily available products with the long-term benefits of waste prevention will be an ongoing challenge.

What Are Some Emerging Trends in Source Reduction?

Many companies are becoming more involved in source reduction by remanufacturing and reusing components of their products or the entire product. A toner cartridge for a laser printer is an example of a product that once was disposable but now is manufactured to be reused. Many products are manufactured to use "modular," or replaceable, units.

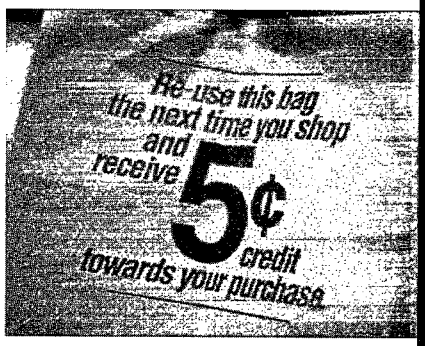
One manufacturer of photocopy machines takes back and remakes equipment from more than 30,000 tons of used photocopiers. Parts from returned machines that meet internal criteria for manufacturing are reprocessed into new products. Parts that do not meet remanufacturing criteria and cannot be repaired are often ground, melted, or otherwise recycled into basic raw materials. The company estimates annual savings of several hundred million dollars in raw material, labor, and disposal as a result of design changes and product return programs.

Other companies are also taking advantage of more environmentally preferable ingredients as ways to reduce the weight of packaging. Some supermarkets across the country have instituted shelf-labeling programs to highlight products with less packaging or less toxic ingredients. Purchasing these items shows manufacturers that consumers encourage and support source reduction.

How Can You Help?

Students can play an important role in protecting the environment by practicing source reduction. Here are some simple practices to help prevent waste:

- Donate old clothes and other household items so they can be reused or sold for reuse.
- Consider taking a thermos of juice to school instead of individual disposable containers.
- Use concentrated products to get more product with less packaging.
- Use double-sided copying and printing features.
- Buy pens, pencils, toothbrushes, and other items with replaceable parts.



- Use a durable lunch container or bag instead of a disposable one.
- Consider using environmentally preferable cleaning products instead of those that contain potentially toxic ingredients.
- Consider buying items that have been remanufactured or can be reused, such as toner cartridges for the printer or tires for the car.
- Encourage companies to reduce unnecessary packaging and the use of hazardous components in products. Many companies offer toll-free numbers and Web sites for these comments.
- Compost cafeteria food waste and use the finished compost to mulch the plants and trees around the school grounds.

Additional Information Resources:

Visit the following Web sites for more information on source reduction and solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA, Office of Solid Waste site on source reduction: <www.epa.gov/epaoswer/non-hw/muncpl/reduce.htm>
- U.S. EPA, Office of Solid Waste site on global climate change and waste reduction: <www.epa.gov/globalwarming/actions/waste/index.htm>
- Reuse Development Organization: <www.redo.org>

To order the following additional documents on source reduction and municipal solid waste, call EPA toll-free at 800 424-9346 (TDD 800 553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *The Solid Waste Dilemma: Agenda for Action* (EPA530-SW-89-019)
- *Planet Protector's Club Kit* (EPA530-E-98-002)
- *A Collection of Solid Waste Resources*—CD-ROM
- *Reusable News* newsletters
- *Municipal Solid Waste Source Reduction–A Snapshot of State Initiatives* (EPA530-R-98-017)
- *National Source Reduction Characterization Report for Municipal Solid Waste in the United States* (EPA530-R-99-034)
- EPA's WasteWise program puts out *Bulletins* and *Updates* that deal with source reduction. To obtain applicable issues, call the WasteWise helpline at 800 EPA-WISE (372-9473) or visit the Web site at <www.epa.gov/wastewise>.

Discovering Nature's Packaging

Art

Objective

To teach students that some food items come in their own natural packaging.

Key Vocabulary Words

Packaging
Compost

Activity Description

Circle and color the items that have their own natural packaging.

Duration

1 hour

Materials Needed

- Copies of the *Find Nature's Packaging* worksheet for each member of the class
- Crayons or markers

Skills Used

Observation/classification
Motor skills

Activity

Step 1: Discuss how some food products have their own natural packaging that protects the part people eat. If possible, bring in examples of items that have natural packaging (e.g., bananas, unshelled nuts, oranges) and others that do not (e.g., cheese, crackers, soda). Discuss how nature's packaging can be used in compost, which returns materials to the earth. Refer to the Teacher Fact Sheet titled *Composting* on page 109 for background information on the composting process.

Step 2: Distribute the *Find Nature's Packaging* worksheet and pass out crayons or markers. Ask the students to circle the items that have natural packaging.

Step 3: Ask the students to color the items on the worksheet.

Assessment

1. Ask students what items have their own packaging.
2. Ask students what we can do with natural packaging instead of throwing it away.

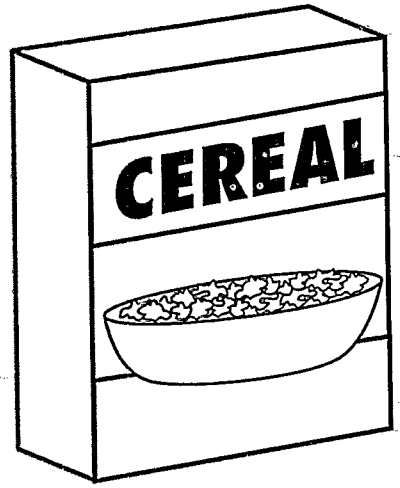
Enrichment

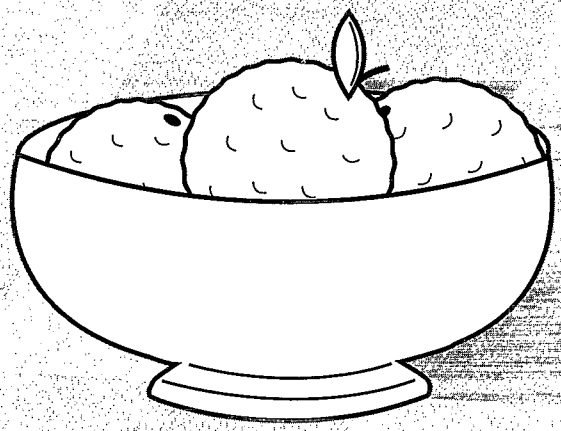
1. Start a vermicomposting bin in the class to demonstrate how nature's packaging can be recycled rather than thrown away. (See the activity *Worms at Work* on page 127 in the Compost chapter for instructions on how to start a vermicomposting bin.)
2. Bring in a variety of unshelled nuts (e.g., pistachios, walnuts, peanuts). Draw or find a sketch of a face, animal, or a fun object. Photocopy it and give one to each student. Have the students shell the nuts and then glue the shells to the sketch. Use paints to color the picture once the glue has dried.

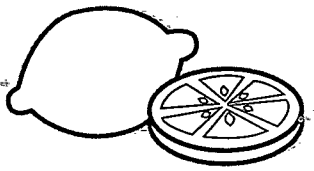
Student Handout

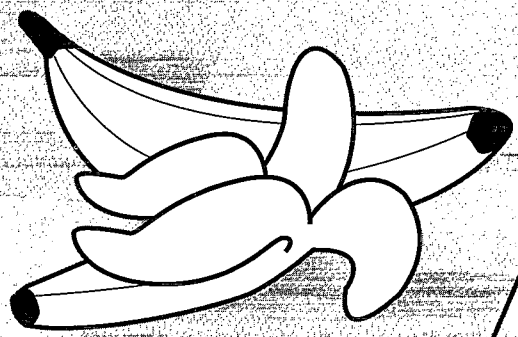
Name:_____

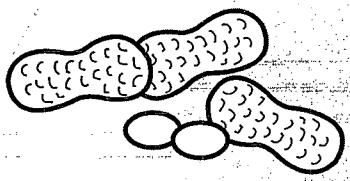
Find Nature's Packaging!

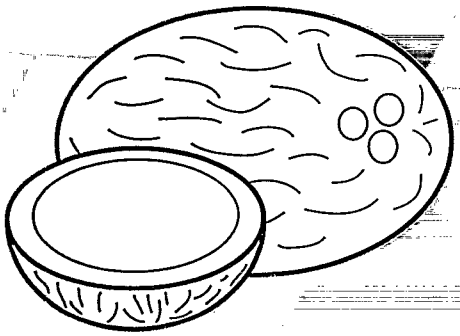


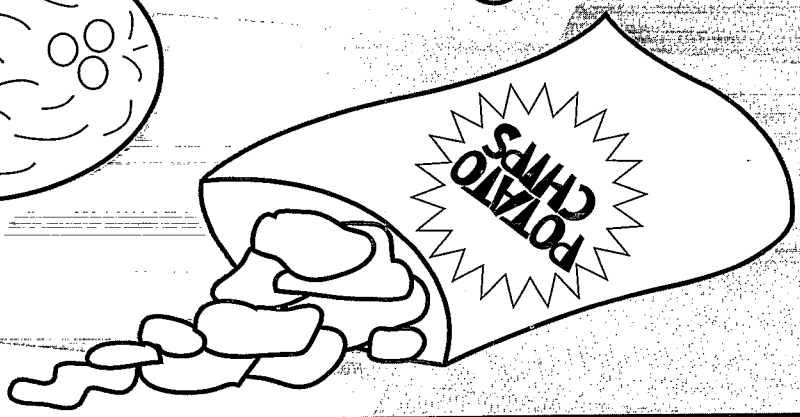












Reuse: Not Just for the Birds

art

Objective

To teach students that, with some creativity, we can make useful things from items we might ordinarily discard in the trash or recycling bin.

Key Vocabulary Words

- Reuse
- Recycle
- Source reduction

Activity Description

Students will bring in plastic milk jugs to create bird feeders.

Duration

1 hour

Materials Needed

- Extra plastic milk jugs (with caps) for students that do not bring in one from home
- Glue
- Scissors
- Paint
- Colored markers
- Two 1-foot long pieces of wood approximately 1/4- to 3/4-inch in diameter (per bird feeder)
- Bird feed for students to put in their finished feeders

Skills Used

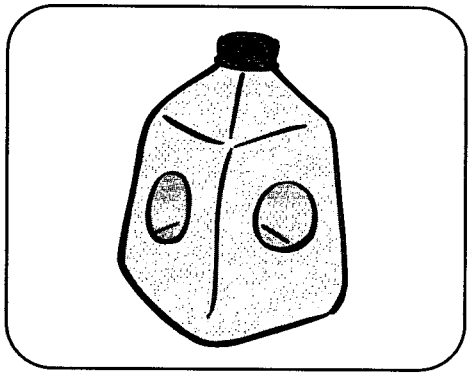
Motor skills

Activity

Instruct students ahead of time to bring in an empty plastic milk jug from home.

Step 1: Introduce the concept of source reduction to the class. Explain that reusing items is a great way to achieve source reduction. (Refer to the Teacher Fact Sheet titled *Source Reduction* on page 133 for background information.)

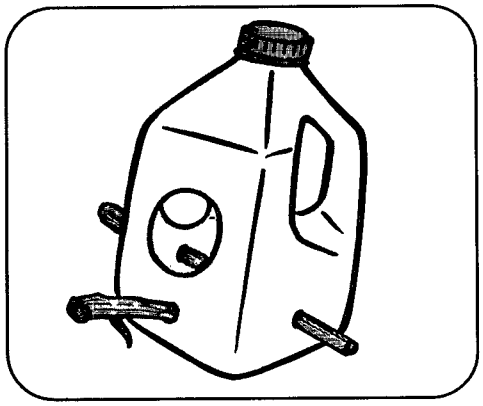
Step 2: With an adult's supervision or help, instruct students to cut out two large holes on different sides of their milk jug for birds to enter.



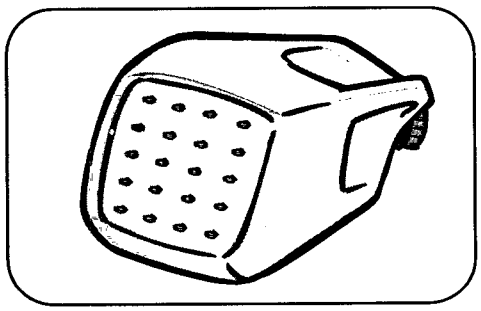
Journal Activity

Have students write a story from the point of view of a bird. What does the bird think of all of the trash it sees from the sky?

Step 3: Provide each student with two 1-foot-long pieces of wood. These could be sticks from a nearby park or even the school grounds. Explain that these wooden pieces will cut through the bird feeder and stick out on either end so that birds can perch on the feeder. With an adult's supervision or help, instruct students



to trace a circle below each of the large holes on the milk jug to match the diameter of the stick. Then, cut out the tracing and insert the wooden pieces through the milk jug.



Step 4: Punch small holes in the bottom of the jug to allow rain water to drain out. Tell students to make sure the holes are not too large, or else the feed might fall through.

Step 5: With markers and/or paints, work with the students to decorate the feeders.

Step 6: Have each student put bird seed in their feeders. Tell the students they can take their feeders home or hang them outside the school.

Assessment

1. Have students name items that can be reused without any alterations. Ask them to list items that can be changed to create a new product (like the bird feeder just created from the milk jug).
2. Ask students to explain why reuse is good for the environment.
3. Ask students what would have happened to the milk jug if it hadn't been used to make the feeder.

Enrichment

1. Organize a waste exchange—with just the class or the entire school. Ask students to bring in something from home they no longer need (e.g., a toy, game, piece of clothing). With teacher facilitation, students can then trade one item for another. Donate unwanted items to a local charity or thrift store.
2. Have students bring in small pieces of "junk" they think look interesting or colorful (e.g., bottle caps, colorful pieces of paper, wood scraps, toy parts, lids, old keys, pieces of old clothing). Then, have the class work together gluing them onto a large piece of wood creating a colorful, attractive mosaic. When the "junk" mosaic is finished, hang it on the wall of the classroom.
3. Instruct students to bring items from home that their families are reusing. Have the students present these items to the class as a "show and tell."

Source Reduction Roundup

language arts

Objective

To teach students the various ways to create less waste in the first place.

Activity Description

Students form teams and work together to answer questions on source reduction.

Materials Needed

- *Source Reduction Questions and Answers* sheet
- Chalk board or flip chart
- Clock or timer

Key Vocabulary Words

Reuse
Source reduction
Disposable
Pollution
Natural resources

Duration

1 hour

Skills Used

Communication
Observation/classification

Activity

Step 1: Discuss source reduction and reuse and how it relates to a clean and healthy environment. Explain what individuals can do to make a difference in the amount of waste that is created. (Refer to the Teacher Fact Sheets titled *Source Reduction* on page 133 and *Products* on page 25 for background information.)

Step 2: Divide the class into two teams. Bring the two teams to the front of the classroom and have them face each other. You might want to line up a row of desks on each side to create a "game show" setting. Flip a coin to decide which team will go first.

Step 3: In preparation for this activity, write the questions on a flip chart, or simply write them one at a time on the board. Present the first question to Team 1. Inform students there are a certain number of answers to this question. The number of correct answers is provided on the attached *Questions and Answers* sheet. Instruct Team 1 that they can consult for 2 minutes before they must try and provide as many of the six answers as possible.

Step 4: As the students in Team 1 state their answers, write them on the board below the question.

Step 5: Team 1 gets a point for every correct answer. If Team 1 was unable to get all six answers referred to on the *Questions and Answers* sheet, then Team 2 gets an opportunity to guess the rest of the answers for that same question. Write Team 2's answers on the board next to Team 1's answers. If Team 1 was able to provide all of the correct answers, then Team 2 doesn't get a chance to answer that question.

Step 6: Go over the answers with the class and discuss any answers that neither team could provide.

Journal Activity

Ask students to make a list of all the things they currently do that create less waste. Then ask them to list other things they could do to further reduce the amount of waste they produce in their daily routines.

Step 7: Start the process over again with question #2, but this time, allow Team 2 to answer first. Keep track of the score and work through all of the questions, alternating which team gets to answer first.

After all of the questions have been answered, the team with the most points wins. For extra credit, see if students can name even more correct answers.

Assessment

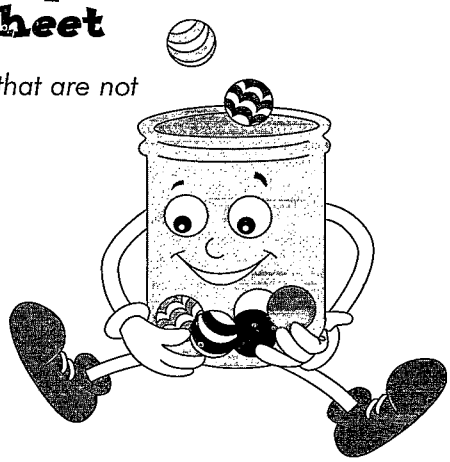
1. Ask students what kinds of activities are involved in source reduction.
2. Have students list some things each of us can do to create less waste and reuse more.
3. Ask students to explain why source reduction is important.

Enrichment

1. Have each team of students devise its own questions and answers for the opposing team, and play again.
2. Organize a clothing drive with the class or the entire school. Donate the used clothing to a local charity or thrift store.

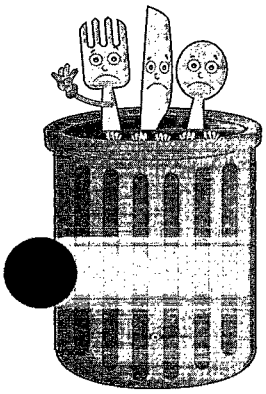
Source Reduction Roundup Questions and Answers Sheet

(Note: Students should be encouraged to think of additional responses that are not on these lists.)



What are 6 ways you can reuse a jelly jar?

1. Pen and pencil holder
2. Cookie cutter
3. Storage container for leftovers
4. Drinking glass
5. Vase for flowers
6. Container for nonfood items such as paper clips, buttons, marbles, or any other small item



What are 6 commonly used items that are often thrown away but could be reused? (Note that some items have both reusable and disposable parts.)

1. Cups
2. Eating utensils (e.g., forks, knives, spoons)
3. Plates
4. Cloth Napkins
5. Lunch bags
6. Batteries

What are 6 benefits of source reduction?

1. Reduces waste
2. Conserves natural resources
3. Reduces pollution
4. Reduces disposal costs
5. Reduces toxic waste in the waste stream
6. Saves money

What are 6 ways you and your family can reduce waste?

1. Use a reusable bag when shopping
2. Bring your lunch in a reusable bag
3. Buy or make your own nontoxic cleaners
4. Make sure you only buy what you need
5. Donate items you don't need anymore instead of throwing them away
6. Use both sides of paper before recycling it

Ecological Picnic

math
science
social studies

Objective

To show students that choices they make about products and packaging can have an impact on the amount of waste they generate.

Key Vocabulary Words

Source reduction
Durable
Nondurable

Activity Description

Plan a picnic with students that produces as little waste as possible.

Duration

Day 1: 1 hour
Day 2: 1 hour, 30 minutes

Materials Needed

- Lunch
- Durable or reusable plates, silverware, cups, napkins, etc.
- Recyclables container
- Garbage container
- Food waste container, if your school composts
- Large scale

Skills Used

Communication
Computation
Observation/classification

Activity

Day 1

Step 1: Select a location to hold your ecological picnic, preferably outdoors with an indoor alternative in case of inclement weather. Find three containers the children can use to separate their recyclables, trash, and food scraps after they have finished their picnic lunch. Check with your cafeteria manager to see if your class can use nondisposable silverware, cups, and plates and if arrangements can be made to provide bag lunches for students who forget or are unable to bring a lunch from home.

Step 2: Explain to students that you will be taking them on an ecological picnic where they will learn how to create less garbage, recycle more, and compost their leftover food items. Introduce the concepts of durable and disposable items and source reduction to the class (refer to the Teacher Fact Sheet titled *Source Reduction* on page 133 for background information). Note how students will put these concepts into practice during the picnic.

Step 3: With students, compile a list of items on the blackboard that people usually bring to a picnic (e.g., paper plates, plastic utensils, paper napkins, chips, drinks, sandwiches). Working through the list on the blackboard, discuss items that can replace the disposable items. Examples might include cloth napkins

Journal Activity

Ask students if they saw any litter where they had their picnic. Ask them how it made them feel to see litter. How could it affect the plants, animals, and other people that use the space?

instead of paper napkins or washable plastic plates instead of paper plates. Explain the benefits of buying in bulk by describing how one large bag of popcorn, for example, leaves less garbage than many smaller bags. You can also discuss picnic games and activities and their impact on the environment. Note that tossing a frisbee or flying kites doesn't create any waste, but having a water balloon fight does.

Step 4: Send a note home with the children explaining how to prepare for the picnic. The note should explain that your class is having an ecological picnic and is trying to limit the amount of garbage left over. Encourage students to discuss what they've learned about source reduction with their parents and to help make preparations by placing food in reusable containers or including as little packaging as possible. Parents can also be invited to volunteer for the picnic. You can conduct the picnic in two ways:

A) Children can bring their own lunch.

B) Children can bring "potluck" items. This may require more time and effort from the parents to provide and transport the items. In class, have the children draw up a list of the things they need and have each of them select something to bring. If your cafeteria is unable to provide silverware, cups, and plates, these will need to be provided by students. In the note to the parents, list the item the student has chosen to bring.

Day 2

Step 1: Before the picnic, explain to the students that they will be weighing the amounts of recyclables, trash, and food scraps left over from the picnic. Ask them to guess approximately how many pounds of material they think will be left over in each of the containers after the picnic. Draw the Eco-Picnic Table shown below on the blackboard and enter their guesses in the first

Eco-Picnic Table

	Recyclables	Food Scraps	Trash	Total Guess
Guess				
Actual Weight (with container)				
Subtract Weight of Empty Container				
Total of Each				

row. Show students which container you want them to use for recyclables, trash, and food scraps and then weigh each of the empty containers on the large scale. Record these numbers on the Eco-Picnic Table. Encourage the students to pick up any litter they find at the picnic site.

Step 2: Go to the picnic site and have the picnic.

Step 3: After lunch, discuss the types of garbage that are left over, as well as the garbage prevented because of the choices students made. Have the students look at the leftover garbage and come up with ways they could have reduced it further.

Step 4: Return to the classroom with the containers. Weigh the three containers to determine the amount of material that must be disposed of, recycled, or composted. How close was the students' original guess? Multiplied by 7 days, how much waste would your classroom dispose of in 1 week? How much would it recycle? How much could be composted? Ask your students to discuss, generally speaking, what would happen if the whole school (or even America as a whole) practiced source reduction as they did for the picnic.

Assessment

1. Ask students why people use disposable items even if they know they make more garbage.
2. Ask students to provide an example of a disposable item that they or their family use regularly. Are there other alternatives that could create less waste? Would they or their family be willing to switch products or change their lifestyles to produce less waste and have less of an impact on the environment?
3. Ask students to think of other ways, beyond a picnic, that they can practice source reduction. Examples might include using cloth napkins and wipes instead of paper towels, buying juice in large bottles or concentrate rather than separate single-serving bottles, using their imagination for games rather than toys, or taking cloth bags when shopping.

Enrichment

1. You could consider conducting this activity by measuring the recyclables, trash, and compostables from a regular day's lunch compared to the ecological picnic lunch.
2. Collect the food scraps left over from the picnic and put them in a vermicomposting bin or compost pile. (Refer to the composting activities section and the Teacher Fact Sheet titled *Composting* on page 109 for more information.)
3. Make fun lunch bags out of an old pair of jeans or shorts. Cut off the legs, sew the bottom closed just under the pockets, and tie thick ribbon through the belt loops for handles. Help students decorate their bags with objects such as buttons, small toys, scrap cloth and ribbon, and fabric paints.

math

science

How Much Lunch Is Left Over?

Objective

To teach students that reducing product packaging can often reduce waste.

Activity Description

Students will weigh their lunches before and after eating to determine how much of their lunch is packaging.

Materials Needed

- Copies of *Packaging Worksheet* for each member of the class
- Resealable plastic bags (approximately 1 quart capacity) for each member of the class
- Small scales capable of weighing items under a pound

Key Vocabulary Words

- Source reduction
- Recycling
- Organics
- Composting
- Landfills
- Disposable

Duration

- 2 hours

Skills Used

- Computation
- Problem solving

Activity

Before conducting this activity, ask all students in the class to bring their lunch from home on a selected day. If some students are on a cafeteria lunch program, consult with cafeteria staff to see if they can provide box lunches on a certain day. If box lunches aren't feasible, have the students use the waste from their regular school lunches (e.g., milk containers, plastic packages, paper napkins, cups, etc.).

Step 1: Explain source reduction to the class. Discuss how it is one of the most important activities we can engage in to help the environment. In addition, discuss how packaging is frequently necessary, but can also create a lot of waste. (Refer to the Teacher Fact Sheets titled *Products* on page 25 and *Source Reduction* on page 133.) Distribute a copy of the *Packaging Worksheet* to each student.

Step 2: Before lunch, ask students to list each piece of their lunch (including the lunch bag or container) in Column A, then weigh each item on a scale and record the weights in Column B on their *Packaging Worksheet*. Send them to lunch with their own resealable bag and instruct them to put all packaging from their lunches in the bag instead of the garbage can. Explain that they should save nature's packaging also (e.g., banana peels, orange rinds, peanut shells).

Journal Activity

Ask students to write a story about what their lives and the environment would be like if everything was disposable and they could not reuse or recycle anything.

Step 3: After lunch, have the students weigh each piece of packaging from their resealable bags and record these numbers in Column C.

Step 4: Have the students compare the weight of each piece of their lunches before eating and after. Based on these numbers, calculate the percentage of the total weight that is the packaging for each lunch item.

Step 5: Instruct students to total Columns B and C and put these figures in the "Total" row of those columns.

Step 6: Discuss recycling, composting, and reuse. Have students put a check in the appropriate box for those packaging items that are reusable, compostable, or recyclable. These checks are for information only, showing students what methods could be used as alternatives to throwing out these items. If students couldn't check any of these alternatives, then the total in their final column (H) would be zero. If, however, they can check off any of these (reusable, compostable, recyclable) columns, then that item's remaining packaging weight gets added to column H.

Step 7: Ask students to compare their totals from Columns B, C, and H and share them with the class. Discuss the types of packaging waste they could not reuse, compost, or recycle. Discuss how this waste could be reduced through other actions, such as their purchasing behavior or the design of the packaging.

Step 8: Start a list on the chalkboard of ways students can create less waste in their lunches (e.g., buying in bulk, reusable lunch bags, reusable utensils).

Assessment

Ask students the following questions:

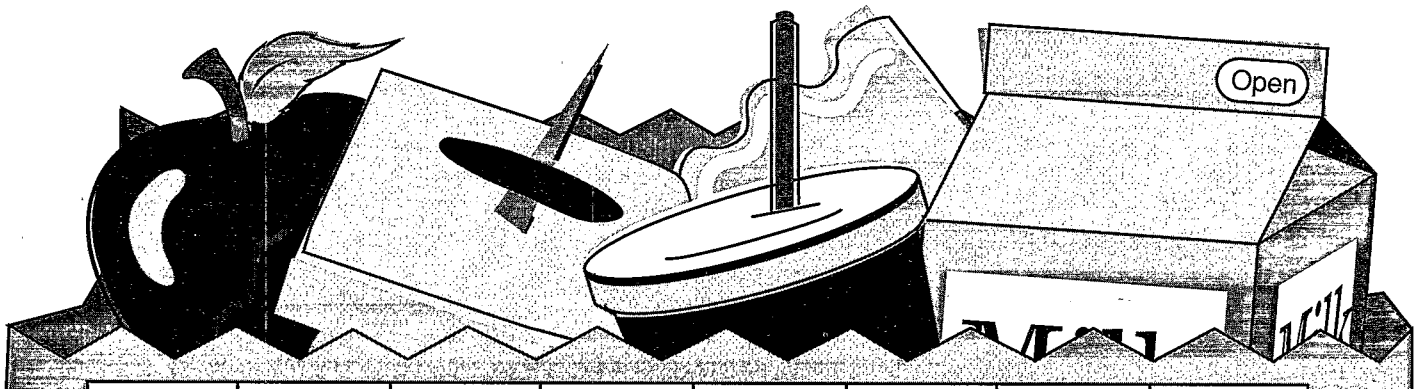
1. Why do manufacturers use packaging?
2. Why did some students have more packaging waste than others?
3. Why do some products have so much packaging?
4. Are there ways to avoid purchasing so much packaging? What are they?
5. Can some packaging be reused or recycled? Which?
6. What is the difference between a disposable and reusable product? What are some examples?

Enrichment

1. Bring in a bulk item and the same amount in individually wrapped single serving containers. Empty the contents of the containers and weigh them. Compare the weights of the one big container to the total weight of the multiple single-serving containers. Discuss what effect the different kinds of packaging have on the environment.
2. Ask students to go to the store and compare the per unit prices of similar items that are packaged differently (e.g., bulk versus individual packages). Instruct them to write down their findings and draw conclusions from them.
3. Have students find a product they believe to be packaged in excess. Ask them to explain why they think the packaging is wasteful. Instruct the students to write a letter or send an e-mail to the manufacturer that sells the overpackaged product asking the company to consider reducing the amount of packaging. Request a response.
4. Instruct students to select a package of their choice and think of ways they could reduce the volume and/or weight of the package without changing its function. Ask students to sketch a rough drawing or write a description of their proposed package and list the reasons why they think the new package would be better.

Packaging Worksheet

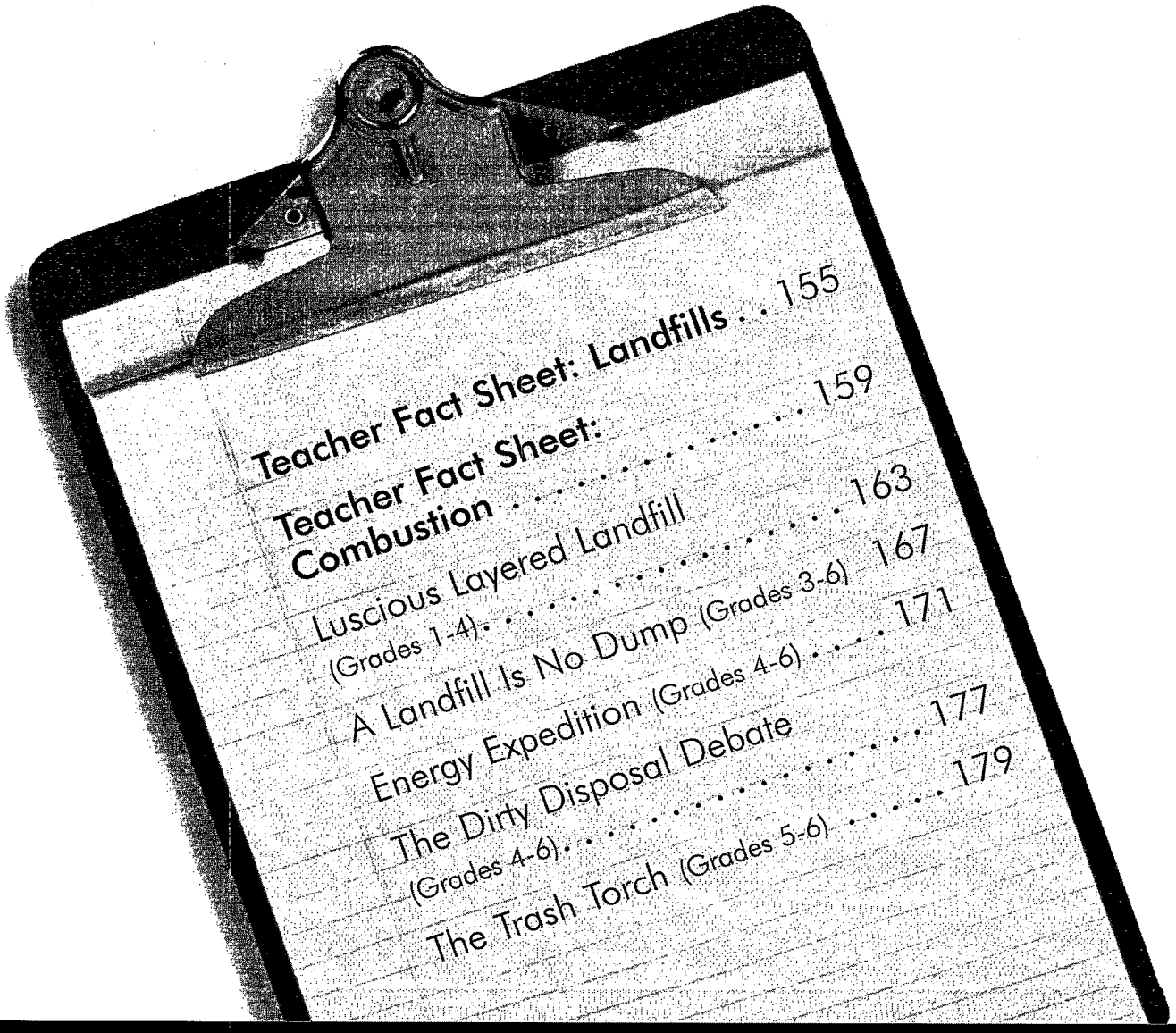
Name: _____



A	B	C	D	E	F	G	H
Item From Lunch	Weight Before Eating (Product and Packaging)	Weight After Eating (Packaging)	Packaging %	Packaging Reusable?	Packaging Compostable?	Packaging Recyclable?	Total Amount of Trash That COULD Have Been Avoided.
1. Example: Banana	170 g	28 g	16%		✔		28 g
2.							
3.							
4.							
5.							
6							
7.							
8.							
9.							
10.							
Totals							

CHAPTER 4

Landfills and Combustion



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The Trash Torch (Grades 5-6) 179

Grade • Subject • Skills Index

Activity Name	Luscious Layered Landfill	A Landfill Is No Dump!	Energy Expedition	The Dirty Disposal Debate	The Trash Torch
Grade Range					
K					
1	✔				
2	✔				
3	✔	✔			
4	✔	✔	✔	✔	
5		✔	✔	✔	✔
6		✔	✔	✔	✔
Subjects Covered					
Math					✔
Science	✔	✔	✔		✔
Language Arts			✔	✔	
Social Studies	✔	✔		✔	✔
Art					
Health					
Skills Used*					
Communication				✔	
Reading			✔	✔	
Research				✔	
Computation					✔
Observation/ Classification	✔	✔			✔
Problem Solving		✔	✔	✔	
Motor Skills	✔				

*See Glossary of Skills for more details.

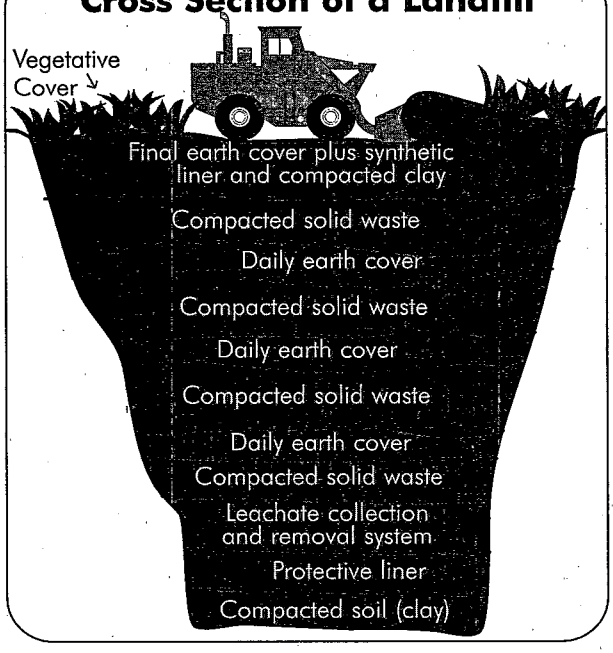
Landfills

What Is a Landfill?

A landfill is a large area of land or an excavated site that is specifically designed and built to receive wastes. Today, about 55 percent of our country's trash is disposed of in landfills (EPA, 1998). Items such as appliances, newspapers, books, magazines, plastic containers, packaging, food scraps, yard trimmings, and other wastes from residential, commercial, and some industrial sources can be disposed of in **municipal solid waste landfills**. Municipal solid waste landfills can also accept some types of hazardous waste, such as cleaning products, paint, and chemicals, as well as some industrial wastes from certain businesses. Many states and communities, however, promote the safe collection of these hazardous wastes through local programs. (See "Are There Landfills for Hazardous Waste?" on page 156 for more information.)

In the past, garbage was collected in **open dumps**. These uncovered and unlined sites allowed **leachate**, a liquid formed by **decomposing** waste, to soak into the soil and **ground water**.

Cross Section of a Landfill



Key Points

- Landfills are the most common form of waste disposal and are an important component of an integrated waste management system.
- Federal landfill regulations have eliminated the open dumps of the past. Today's landfills must meet stringent design, operation, and closure requirements.
- Methane gas, a byproduct of decomposing waste, can be collected and used as fuel to generate electricity.
- After a landfill is capped, the land may be used for recreation sites such as parks, golf courses, and ski slopes.
- Landfills that handle hazardous wastes are specially designed with two sets of liners and two leachate detection systems.

Open dumps also attracted rodents and insects, emitted odors, and created fire hazards. Most of these small and unsanitary dumps have been replaced by large, modern facilities that are designed, operated, and monitored according to strict federal and state regulations. Today's landfills eliminate the harmful and undesirable characteristics of dumps to help protect public health and the environment.

In addition to being safer for the environment and neighboring communities, these larger landfills hold more trash than the dumps of the past. In 1998, about 2,300 municipal solid waste landfills were operating in the United States (EPA, 1998). While this number is significantly smaller than the number of landfills 25 years ago, new landfills—often called megafills due to their size—can accommodate significantly more garbage. This greater capacity is necessary to keep up with the steady growth of **municipal solid waste**.

Are There Landfills for Hazardous Waste?

Each year, about 29 million tons of hazardous wastes are disposed of in landfills or other land disposal sites. Hazardous waste is toxic, ignitable, corrosive, or reactive, or generated from certain industries or manufacturing processes. When it comes to disposing of hazardous waste in landfills, EPA takes additional steps to ensure environmental safety and human health.

While landfills that accept solid waste have a clay and plastic liner and a leachate system to prevent leakage, landfill owners that accept hazardous waste must take extra precautions. For example, a hazardous waste landfill must have two sets of liners, one consisting of a special plastic, and the other composed of both plastic and a thick layer of soil material. In addition, a landfill accepting hazardous waste must have two leachate detection systems instead of just one.

Before hazardous waste even reaches a landfill, however, it must be treated differently than solid waste. If hazardous waste is bound for disposal in a landfill, it is regulated under EPA's Land Disposal Restrictions program. Through this program, hazardous waste must undergo treatment that will destroy or immobilize its hazardous components before it is sent to a landfill. For example, when a business generates hazardous waste, it must either treat that waste itself, or send it to a special facility for treatment, before sending the waste to a landfill.

How Does a Landfill Work?

A typical modern landfill is lined with a layer of clay and protective plastic to prevent the waste and leachate from leaking into the ground or ground water. The lined unit is then divided into **disposal cells**. Only one cell is open at a time to receive waste. After a day's activity, the garbage is **compacted** and covered with a layer of soil to minimize odor, pests, and wind disturbances. A network of drains at the bottom of the landfill collects the leachate that flows through the decomposing waste. The leachate is sent to a **leachate recovery facility** to be treated. Methane gas, carbon dioxide, and other gases produced by the decomposing waste are monitored and collected to reduce their effects on air quality.

Landfills are regulated by federal and state laws. The federal laws dictate where landfills can be located, such as away from unstable land prone to earthquakes or flooding, and require them to be lined and have a **leachate collection system**. In addition, landfill owners must monitor and collect explosive gases; regularly test nearby ground water; and compact and cover waste with a layer of soil on a daily basis.

Many states require landfill operators to obtain a license and present a plan for how the site will be safely closed, even though the closing date might be 50 years in the future. Furthermore, federal law requires landfill owners to set aside the money to close the landfill properly and support ongoing monitoring activities. Once a landfill is capped (closed), the operator must monitor the site for gas and leachate for a minimum of 30 years after the closing date. In addition to federal regulations, each state has its own landfill requirements, which are often more stringent than the federal laws.

What Are the Benefits of Landfills?

In addition to providing a cost-effective, safe method to dispose of ever-increasing amounts of trash, landfills often provide other services to the community. For example, some landfills collect methane, a gas created by decomposing

Landfill Facts

- The first garbage dump was created in 500 BC by the ancient Greeks in Athens. Residents were required to take their trash 1 mile away from the city walls to dump.
- Paper takes up as much as 50 percent of all landfill space. Recycling 1 ton of newspapers would save 3 cubic feed of that space.
- In a study of waste buried for more than 15 years, Professor William Rathje of the University of Arizona found legible newspapers and chicken bones with meat still on them, proving that waste does not decompose completely in a landfill.

(Sources: The League of Women Voters' Garbage Primer, 1993; Rubbish! The Archaeology of Garbage by William Rathje, 1990; Anchorage Recycling Center, 2000)

garbage that can contribute to **global climate change**, and convert it into an energy source. In addition, after a landfill is capped and a certain amount of time has passed, the land might be reused for parks, ski slopes, golf courses, and other recreation areas.

What Are the Challenges of Landfills?

Though regulations have made landfills safer to the public and the environment, public opposition, high land prices, and environmental concerns can make it difficult to find suitable places for new landfills.

Landfills can pose other problems if not properly designed or managed. If a liner leaks, for example, the underlying soil and ground water can become contaminated. Additionally, since landfills are often located in remote areas, waste must be hauled long distances, which might result in environmental impacts from increased truck traffic (e.g., air pollution) and noise from truck traffic and the use of equipment onsite. Additionally, within a given municipality, landfills often compete for local garbage. Competition can lead to reduced support for recycling and other waste reduction programs.

Issues also might arise if a landfill is located close to a community. Many people do not want landfills near their homes. The NIMBY (Not in My Backyard) attitude can make finding a landfill site very challenging.

Putting Landfill Gas to Use

1 million tons of waste within a landfill creates 300 cubic feet per minute of landfill gas, or one megawatt of electricity. That is enough to power 700 homes for a year. Removing that much methane gas from the atmosphere is equal to taking 6,100 cars off the road for a year.

(Source: EPA, 2000)

What Are Some Emerging Trends?

Increased waste generation requires landfill operators and managers to constantly evaluate and improve current disposal methods. One strategy to speed the rate of decomposition of landfill waste is to recirculate the collected leachate by pouring it over the cells and allowing it to filter through the rotting garbage.

Another trend that is becoming common for landfill operators is collecting methane gas from the landfill and using it as the energy source to power the landfill or selling it to a local utility provider, company, or even greenhouses. This process allows landfills to reduce their dependence on precious **fossil fuels** and save money.

A new trend that is gaining attention is **landfill reclamation**, in which old cells are excavated to recover recyclable items. This process, in which recovered recyclables, soil, and waste can be sold, reused, or burned as fuel, is a new approach used to expand landfill capacity and avoid the cost of aquiring additional land.

Additional Information Resources:

Visit the following Web sites for more information on municipal solid waste landfills:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA, Office of Solid Waste site on landfills: <www.epa.gov/epaoswer/non-hw/muncpl/disposal.htm>
- U.S. EPA Landfill Methane Outreach Program: <www.epa.gov/lmop>

For more information on the disposal of hazardous waste in landfills, visit:

- U.S. EPA, Office of Solid Waste site on Land Disposal Restrictions: <www.epa.gov/epaoswer/hazwaste/ldr>
- U.S. EPA, Office of Solid Waste site on RCRA Hotline Training Modules (hazardous waste land disposal units): <www.epa.gov/epaoswer/hotline/modules.htm>

To order the following additional documents on municipal solid waste, call EPA toll-free at 800 424-9346 (TDD 800 553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *Sites for Our Solid Waste: A Guidebook for Public Involvement* (EPA530-SW-90-019).
- *Safer Disposal of Solid Waste: The Federal Regulations for Landfills* (EPA530-SW-91-092)
- *Decision-Makers' Guide to Solid Waste Management, Volume II* (EPA530-R-95-023)
- *A Collection of Solid Waste Resources*—CD-ROM

The following trade associations can provide information about landfills as well:

National Solid Waste Management Association
4301 Connecticut Avenue, NW., Suite 300
Washington, DC 20008
Phone: 202 244-4700
Fax: 202 966-4841
Web site: <www.envasns.org/nswma>

Solid Waste Association of North America
P.O. Box 7219
Silver Spring, MD 20907-7219
Phone: 301 585-2898
Fax: 301 589-7068
Web site: <www.swana.org>

Combustion

What Is Combustion?

Recycling, composting, and source reduction are vital activities for effective solid waste management, but 100 percent of people's trash cannot be handled by these methods. The remaining waste must be deposited in landfills or combusted (burned). Because of limited space, landfills are not always a viable option in many cities, making **combustors** (commonly referred to as incinerators) an important part of a community's integrated waste management system. Burning garbage can decrease the volume of waste requiring disposal by 70 to 90 percent.

Before the late 1970s, many people burned garbage in their backyards and in simple private and municipal combustors. These methods did not burn garbage completely, however, and allowed pollutants to escape into the atmosphere. With the passing of the Clean Air Act, combustor owners were directed to develop more effective methods of pollution control. Today's municipal waste combustors release significantly less pollutants into the air than the "backyard burners" and simple combustors. More than 100 municipal waste combustor plants currently exist nationwide, and nearly 20 percent of the municipal solid waste generated in the United States is combusted.

Key Points

- Municipal waste combustors burn waste at high temperatures to reduce its volume.
- The heat produced by burning waste in municipal waste comubstors can be recovered as useful energy.
- Municipal waste combustors reduce the volume of garbage by 70 to 90 percent.
- Ash is a byproduct of combustion that must be disposed of in landfills or reused.
- Air pollution control equipment helps reduce air emissions.
- Specially designed incinerators can be used as a means of handling hazardous waste. The burning process reduces the toxicity of organic compounds in the waste.

Facts about Municipal Waste Combustors

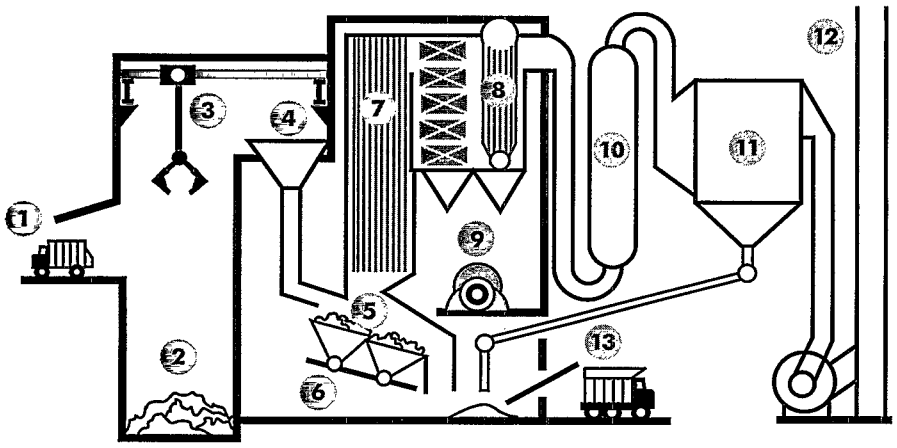
- Fire in the boiler of a combustor is often as hot as flowing lava (between 1,800 and 2,200 degrees Fahrenheit).
- In 1874, a new technology called "the destructor" provided the first combustor of municipal garbage in England.
- The first garbage incinerator in the United States was built on Governor's Island, New York, in 1885.

(Sources: Integrated Waste Services Association, 2000; Rubbish! The Archaeology of Garbage by William Rathje, 1990)

How Do Municipal Waste Combustors Work?

Municipal waste combustors dispose of trash by burning it at high temperatures. Not all municipal waste combustors are designed alike, but they function in a similar manner. Typically, a facility collects waste in a garbage receiving area or pit, where the garbage is mixed by a crane. The crane operator looks for large items

How Typical Combustion Facilities Work



1. Tipping area for trucks
2. Refuse pit
3. Refuse crane
4. Hopper, which sends waste to combustion zone
5. Primary combustion zone
6. Underfire air
7. Furnace
8. Heat exchanger
9. Turbine
10. Scrubber, to remove acid gases
11. Fly ash and dust collector
12. Stack
13. Bottom ash and fly ash collection and transport

Hazardous Waste Combustion

In addition to combustion facilities that accept municipal (nonhazardous) waste, specially designed incinerators, boilers, and industrial furnaces, can burn hazardous waste. Hazardous waste, which is toxic, ignitable, corrosive, or reactive, can be produced by businesses or manufacturing operations. Combustion has some key advantages as a means of managing hazardous waste. First, burning hazardous waste reduces the volume of waste by converting solids and liquids to ash. Second, the burning process destroys toxic organic compounds in waste. Third, disposal of the ash in a landfill is safer and more efficient than disposal of untreated hazardous waste. The ash generated from hazardous waste combustion must be tested and, if found to be hazardous, must be treated for remaining toxicity before it is disposed of in a landfill.

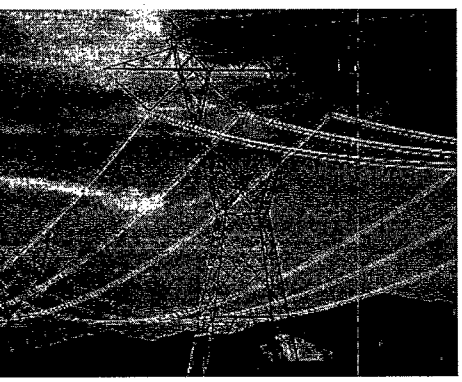
that are not suitable for combustion (e.g., batteries and refrigerators) and removes them from the pit. The crane operator also uses the crane to lift piles of garbage into a large chute. From the chute, garbage falls into a combustion chamber or furnace and then moves along a series of sloping grates that work like conveyer belts. The garbage is burned as it moves forward.

After garbage is burned, some matter remains in the form of ash. There are two types of ash: bottom ash and fly ash. Bottom ash is the heavier, nonburnable material, such as glass and metal, that falls through the grate after burning. Large pieces of metal accumulate in this ash and are extracted from the ash with magnets. Bottom ash accounts for the majority of ash produced by incinerators, about 75 to 90 percent. Fly ash includes lighter particles that rise with hot gases as the garbage is burned and are captured by air pollution control equipment in the stacks. All ash generated by combustion facilities must be tested to determine if it is hazardous. If deemed hazardous, the ash is subject to special hazardous waste disposal regulations. If the ash

proves nonhazardous, it may be deposited in landfills specially designed to store it. Currently, studies are under way to investigate ways to reuse ash; for example, to replace soil as a landfill cover (generally applied at the end of each day to minimize odor, pests, and wind disturbances). Ash might also be used in road and building construction and as part of artificial offshore reefs. Whether the leftover ash is recycled or landfilled, it takes up much less space than the same materials in their original form.

What Are the Benefits of Municipal Waste Combustors?

Most municipal waste incinerators in the United States generate energy in the form of electricity because certain materials, such as paper, plastics, wood, and packaging, make excellent fuels. Producing this energy has about the same environmental impact as energy produced from natural gas and less of an environmental impact than energy produced from oil or coal. In other words, generating energy from municipal waste combustors contributes no more pollution—and sometimes less—than processes generating electricity using natural gas, oil, or coal. Waste-to-energy plants also reduce the need to generate electricity from nonrenewable natural resources such as oil and coal.



What Are the Challenges of Municipal Waste Combustors?

Although technologies to control pollution have improved significantly, burning certain materials still produces chemicals that contribute to air pollution. To minimize emissions of air pollutants into the atmosphere, municipal waste incinerators use special equipment (e.g., scrubbers and dust collectors) to remove pollutants. To protect air quality and monitor the hazardous constituents in ash, EPA established regulations that apply to all large municipal solid waste units (those with the capacity to burn more than 250 tons of garbage per day). The regulations significantly reduce toxic air emissions such as dioxin, acid gas, lead, cadmium, and mercury.

Many people do not want incineration sites near their homes. The **"NIMBY (Not In My Back Yard)"** attitude makes finding appropriate sites for municipal waste combustors a challenge for many municipalities. There are, however, opportunities for the public to participate in deciding where a combustor will be located. Officials must hold a public meeting to inform the community about the size of the combustor, as well as the amount of waste generation and ash to be discarded.

Additional Information Resources:

Visit the following Web sites for more information on municipal and hazardous waste combustion and solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA, Office of Solid Waste site on combustion: <www.epa.gov/epaoswer/non-hw/muncpl/disposal.htm>
- U.S. EPA, Office of Solid Waste site on hazardous combustion: <www.epa.gov/epaoswer/hazwaste/combust>

To order the following additional documents on combustion and solid waste, call EPA toll-free at 800 424-9346 (TDD 800 553-7672) or look on the EPA Web site <www.epa.gov/epaoswer/osw/publicat.htm>.

- *Decision-Makers' Guide to Solid Waste Management, Volume II* (EPA530-R-95-023).
- *Sites for our Solid Waste: A Guidebook for Public Involvement* (EPA530-SW-90-019)
- *A Collection of Solid Waste Resources*—CD-ROM (EPA530-C-98-001)

The following trade associations can provide information about combustion as well:

Integrated Waste Services Association
1401 H Street, NW., Suite 220
Washington, DC 20005
Phone: 202 467-6240
Fax: 202 467-6225
E-mail: Iwsa@ix.netcom.com

Environmental Industry Associations
4301 Connecticut Avenue, NW., Suite 300
Washington, DC 20008
Phone: 202 244-4700
Fax: 202 966-4841

Solid Waste Association of North America
P.O. Box 7219
Silver Spring, MD 20907-7219
Phone: 301 585-2898
Fax: 301 589-7068
Web site: <www.swana.org>

Luscious Layered Landfill

science

social studies

Objective

To teach students how a modern landfill functions (that is, how its many layers contain garbage and prevent leakage into soil or ground water).

Activity Description

Students will construct edible models of a landfill to learn about its different layers and their functions.

Materials Needed

- One 8-ounce pliable clear plastic cup per student
- Five chocolate sandwich cookies per student
- One 8-ounce box of raisins
- One fruit rollup per student
- Two graham crackers per student
- Two red licorice sticks per student
- One package of birthday candles
- One set of matches
- One scoop of chocolate ice cream (or pudding) per student
- Two tablespoons of whipped cream per student
- One plastic knife per student
- One plastic fork per student
- One handful (per student) of a variety of small chewable candies (e.g, chocolate, peanut butter, fruit)
- One copy of *Anatomy of a Landfill* handout per student

Key Vocabulary Words

Landfill
Clay liner
Plastic liner
Leachate
Leachate collection pipes
Methane
Decompose
Rodent

Duration

1 hour

Skills Used

Observation/classification
Motor skills

Activity

Step 1: Refer to the Teacher Fact Sheet titled *Landfills* on page 155 for background information. Explain the purpose of a landfill to students and explain that they will construct their own model landfills in class. Copy and distribute the *Anatomy of a Landfill* handout. Using the handout, go over each layer's name and function with students.

Step 2: Distribute a cup and five chocolate sandwich cookies to each student. Explain that the cup represents an excavated hole in the ground.

Step 3: Have students carefully "unscrew" two of their cookies so that one half has white cream and the other is bare. Students should have two cookie halves with white cream and two cookie halves without cream. Crush the bare cookie halves into small pieces and put

Journal Activity

Ask students to list some common items that they throw away. What do they think people threw away 100 years ago? Ask them to predict what we will throw away in the future. What would they expect to find in a landfill in another country (pick a country)? Ask students to compare these answers with the United States.

them into the cup. Explain that the crushed cookies represent a layer of soil that is placed in the bottom of real landfills.

Step 4: Next, have the students take the cookie halves with white cream and break them up into two or three pieces. Direct students to place the pieces in the cup with the white cream face up. These pieces represent a layer of clay that is put on top of the soil in real landfills.

Step 5: Have students use the plastic knife to cut their fruit rollups to roughly fit the size of the top of cup and slide them into place (will push up on sides) on top of the cookies to represent a plastic liner. Plastic liners prevent leachate from escaping from a landfill into the ground. Leachate is liquid created when trash decomposes.

Step 6: Have students crush and add their graham crackers to represent a sand layer. This layer is used to prevent liquids in landfills from seeping out.

Step 7: Have students place raisins on top to represent a layer of pebbles. Like the sand layer, pebbles provide further protection against leachate leaks.

Step 8: Have students rip the licorice sticks in half and bite off both ends to represent leachate pipes. Stick pipes into pebble layer. These pipes collect any leachate that collects on top of the liners.

Step 9: Ask students to sprinkle the candies on top of the raisins. The candies represent pieces of garbage. Ask students to think about what happens when a landfill or "cup" is filled up with trash or "candies"? How can they reduce the amount of trash that they send to the landfill? (Refer to the Teacher Fact Sheet titled *Recycling* on page 73 for background information.)

Step 10: Give each student a scoop of ice cream on top of the candies. Then, have the students add one more layer of candies on top of the ice cream. The ice cream layer represents the seepage created from rain seeping through the garbage. Explain that in a real landfill, more layers of garbage or "candies" are placed on the landfill each day, so that liquid from the decomposition of the trash is continually created.

Step 11: Direct students to "unscrew" their two remaining cookies and crush another layer of the bare cookie halves, without the cream, on top of the candies and ice cream to represent soil again. (Students can eat the other cream-covered cookie halves.) This layer reduces the amount of rain water that reaches the garbage.

Step 12: Each student should use a layer of whipped cream to "cap" the landfill or cover it (as would a plastic cap) in order to prevent odor, insect, and rodent problems.

Step 13: In front of the class, stick a candle deep into your own edible "landfill" and light it. Explain that the candle represents the methane gas recovery system, which draws methane gas from the decomposing garbage. The flame represents energy that can be generated by burning the captured methane gas.

Step 14: Have students eat their landfills as a snack. When they get to the bottom of their cup, ask students to notice whether their cookie or "soil" layer is dry, or whether the ice cream or "leachate" leaked past the many layers and the fruit roll-up liner to soak the cookies. Remind students that if they built their landfill correctly, their cookies will be dry, just as in a real landfill the soil remains protected from leachate.

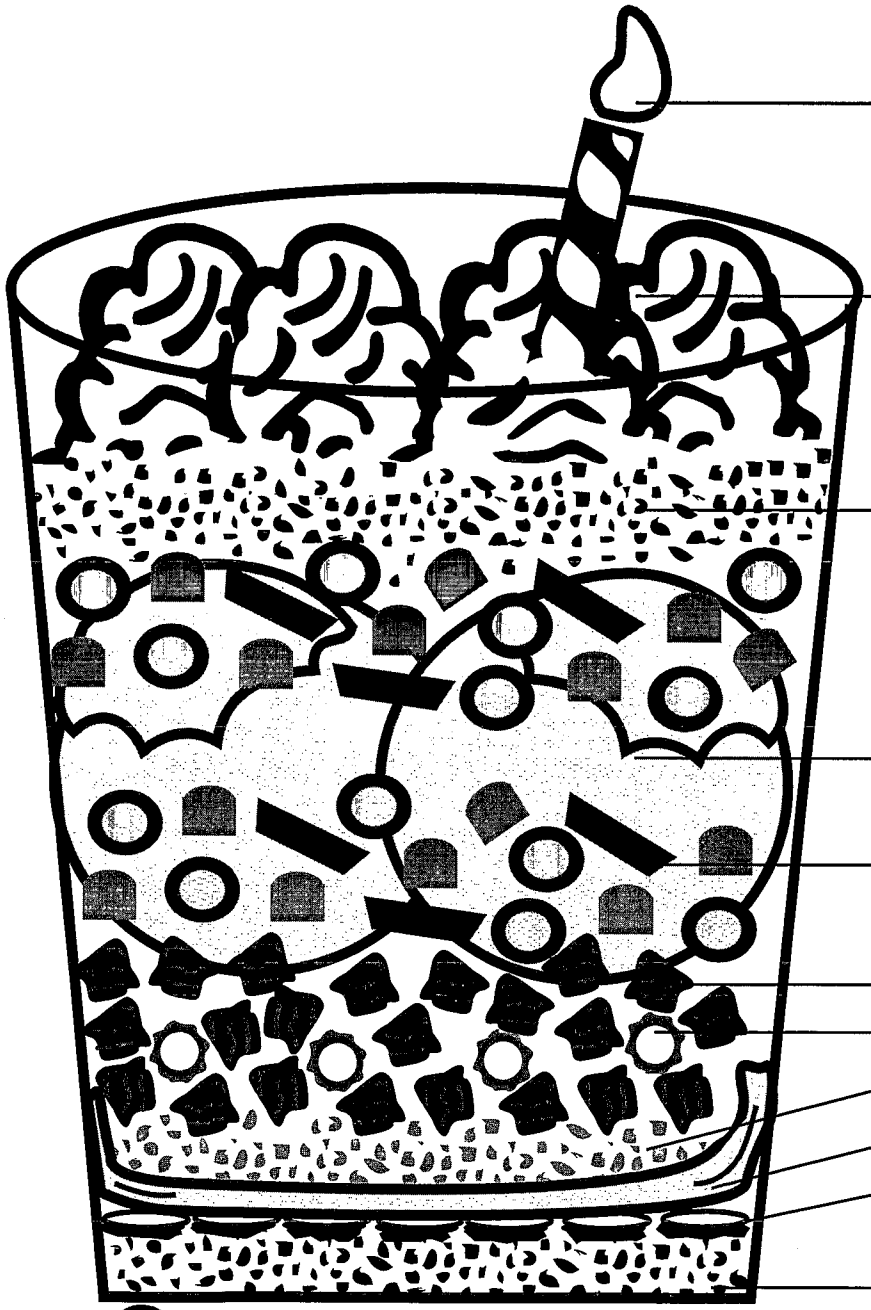
Assessment

1. After enjoying the luscious layered landfill as a snack, ask the students if they remember the purpose of all the different parts, such as the fruit roll-up, the licorice, the cookies, and your candle.

Enrichment

1. Contact a landfill in your community and take a tour. Ask to hear about all the different parts of the landfill. If your landfill recovers methane for energy, ask for a tour of the plant.
2. Have students conduct a survey of friends and family asking them where their garbage goes. Have them record peoples' responses and determine whether they are well informed. In class, discuss the survey results.

Anatomy of a Landfill



Methane gas recovery system (candle): recovers gas for energy from decomposing garbage

Landfill cap (whipped cream): prevents odor, insect, and rodent problems

Soil layer (cookie pieces): used to cover daily garbage

Leachate (ice cream): natural byproduct of decomposing garbage

Garbage (candies): added daily from communities

Pebble layer (raisins): prevents liquid from seeping out

Leachate pipe (licorice stick): collects leachate

Sand layer (graham crackers): prevents liquid from seeping out

Plastic liner (fruit rollup): prevents leachate from escaping into the ground

Clay layer (cookie pieces): absorbs any leachate (or liquid) that escapes the plastic liner

Soil layer (crushed cookies): lines the bottom of the landfill

A Landfill Is No Dump!

science

social studies

Objective

To teach students where garbage goes and explain the difference between unlined trash "dumps" of the past and today's specially designed landfills.

Activity Description

Students will construct models of an old-fashioned "dump" and a modern landfill in class and observe their differences.

Materials Needed

- Two plastic colanders (9 inches wide by 4 inches deep)
- Two cake pans (9 inches)
- One 10-pound bag of garden soil
- One 32-ounce bottle of distilled water
- Small pieces of typical home-generated garbage (see below)
- One package of modeling clay
- One roll of colored (red) crepe paper
- Clear tape
- One measuring cup
- One pair of scissors
- One package or roll of litmus (pH) paper
- One copy of the *Landfill Log* worksheet for each student

Key Vocabulary Words

- Organic
- Municipal solid waste
- Landfill
- Leachate
- Groundwater
- Turbidity
- pH

Duration

Landfill creation: 1 hour
Observation over 4 weeks: 15 to 20 minutes each week

Skills Used

- Observation/classification
- Problem solving

Activity

Step 1: Photocopy and distribute *Landfill Log* worksheets to each student. Bring in some small pieces of garbage from your home, such as potato peels, apple cores, newspaper, and plastic yogurt containers. Introduce the following topics or concepts (refer to the Teacher Fact Sheets titled *Solid Waste* on page 41 and *Landfills* on page 155 for background information):

- Trash generation and disposal.
- How trash has been disposed of in the past and how it is disposed of now.
- Explain, in general terms, how a landfill works.
- Define each of the key vocabulary words used in the lesson.

Journal Activity

Ask students to write a haiku or sonnet about where their garbage goes.

Step 2: Begin the exercise by asking a student volunteer to line one colander with flattened modeling clay, patting it out flat like a pie crust. Explain that this represents the liner of a sanitary, modern landfill. Do not line the second colander. Note that it represents an old-fashioned, unsanitary dump.

Step 3: Have several students cut the different garbage items you brought in from home into small pieces, about 2 inches square.

Step 4: Have a few student volunteers place this trash and the garden soil in the colanders in alternate layers until the colanders are full. For each layer, add 1 inch of garbage covered by 1/4 inch of dirt. Add several strips of red crepe paper as one layer toward the bottom of the colanders and cover them with more dirt. (The red crepe paper will emphasize the seepage of water through the unlined dump.)

Step 5: Place cake pans under the colanders to collect the seepage.

Step 6: Have students simulate "rain" on the "landfills" by pouring 1 cup of water onto each colander twice a week for 4 weeks. Ask students to observe the changes that take place. Pay particular attention to any water that collects in the cake pans. The unlined colander's seepage should be observable and colored by the crepe paper. The lined colander should not leak.

Step 7: After every "rain" session, have the students use a measuring cup to measure the water that leaked out of the unlined colander. Have students observe and record the water's color and turbidity. Ask for volunteers to test the pH of the collected water with litmus paper. Ask students to record results and observations in their *Landfill Logs*. For comparison purposes, have students test and record the pH of the distilled water.

Step 8: Next, have student volunteers put the "dirty" water from the unlined colander in a plastic cup. Fill another plastic cup with distilled water.

Step 9: Ask students to pretend that the dirty water or "leachate" had escaped an unlined landfill and reached surrounding plants and animals. Ask them what effect they think the liquid would have on animal or plant life. Ask students to predict how a piece of celery (representing a plant) would react to the leachate or "dirty" water.

Step 10: Insert two pieces of celery—one into the leachate cup and one into the distilled water cup. Point out to students how the celery stalk absorbs all of the color from the crepe paper, or dirt and toxins, of the leachate. Have students record observations about the process and the differences between the two pieces of celery.

Assessment

1. Ask students to explain the differences between the mini-landfills.
2. Ask students to refer to their *Landfill Logs*. How did the color, turbidity, and pH of the leachate and the distilled water differ? Why?
3. Have students describe how an unlined landfill or "dump" can pollute ground water and surrounding soil.
4. Ask students to decide which landfill is better for the environment and why. Which kind of disposal facility would they rather have in their neighborhood?
5. Ask students to define the key vocabulary words of this lesson. Conduct a spelling bee using these words.

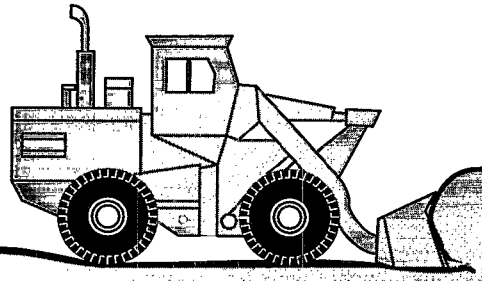
Enrichment

1. Take a field trip to a local landfill. Have kids tour the facility and learn firsthand how it operates. When you return, have students write a paragraph about their visit, including five new facts about landfills that they learned.
2. Contact your state solid waste or environmental agency to find out how many landfills are in your state. If one is located near you, ask how many tons of trash it accepts per day or per year and its lifetime maximum capacity. Have students use data obtained from the agency to calculate how quickly the landfill is filling up. Have students make graphs to show how much longer it can accept garbage at its current rate.

Student Handout

Landfill Log

Name: _____



Observations							
Date	Amount of Leachate	pH of Leachate	pH of Distilled Water	Color of Leachate	Turbidity of Leachate	Celery in Leachate (one-time observation)	Celery in Distilled Water (one-time observation)
Week 1 Rain 1 Rain 2	½ cup	9	7	brown and red	murky and filled with particles		
Week 2 Rain 1 Rain 2							
Week 3 Rain 1 Rain 2							
Week 4 Rain 1 Rain 2							

Energy Expedition

Objective

To introduce students to the concept of energy and teach them about its connection to trash.

Activity Description

Students will complete the *Energy Expedition* worksheet individually or in pairs.

Materials Needed

- One photocopy of the *Energy Expedition* worksheet per student
- One pencil or pen per student

Key Vocabulary Words

Potential	Combustion
Fossil	Methane
Coal	Solar
Gas	Water
Trash	Oil

Duration

1 hour

Skills Used

Reading
Problem solving

science

language arts

Activity

Step 1: Distribute one copy of the *Energy Expedition* worksheet to each student. Introduce the concept of energy—what it is, what it's used for, and where it comes from. Next, discuss the link between energy and trash; explain how we can capture methane gas from landfills to burn as energy for the community or local businesses. In addition, discuss how we can capture energy by burning our trash in combustion facilities. Refer to the Teacher Fact Sheets titled *Landfills* on page 155 and *Combustion* on page 159 for background information.

Step 2: Depending on student ability levels, use the Teacher Answer Key to go over the key vocabulary of this activity in advance, discussing each word and its meaning with the class. This will help them correctly complete the written activity later.

Step 3: Direct students to complete the *Energy Expedition* worksheet, working either individually or in pairs.

Journal Activity

Have students keep an energy diary for one week. Ask them to record every time they use energy in a day (for example, turning on lights, using a car or bus). Where could they have saved energy (for example, riding a bike instead of using a car)?

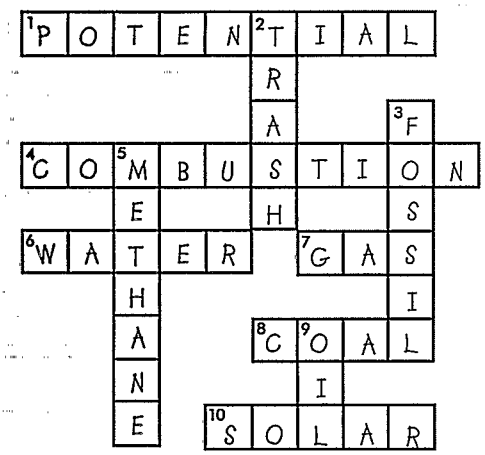
Assessment

1. Collect the *Energy Expedition* worksheets and assess students' work.
2. Ask students to list at least four different sources of energy.

Enrichment

1. Visit a waste-to-energy facility as a field trip. Have students write summaries that explain how the facility works.
2. Divide the class into groups and assign them each an energy concept (such as those introduced in the *Energy Expedition* worksheet.) Ask each group to conduct research on their topic and prepare a presentation to teach the class about their findings.
3. Conduct a spelling bee using the energy words featured on the *Energy Expedition* worksheet.

Crossword Puzzle Key



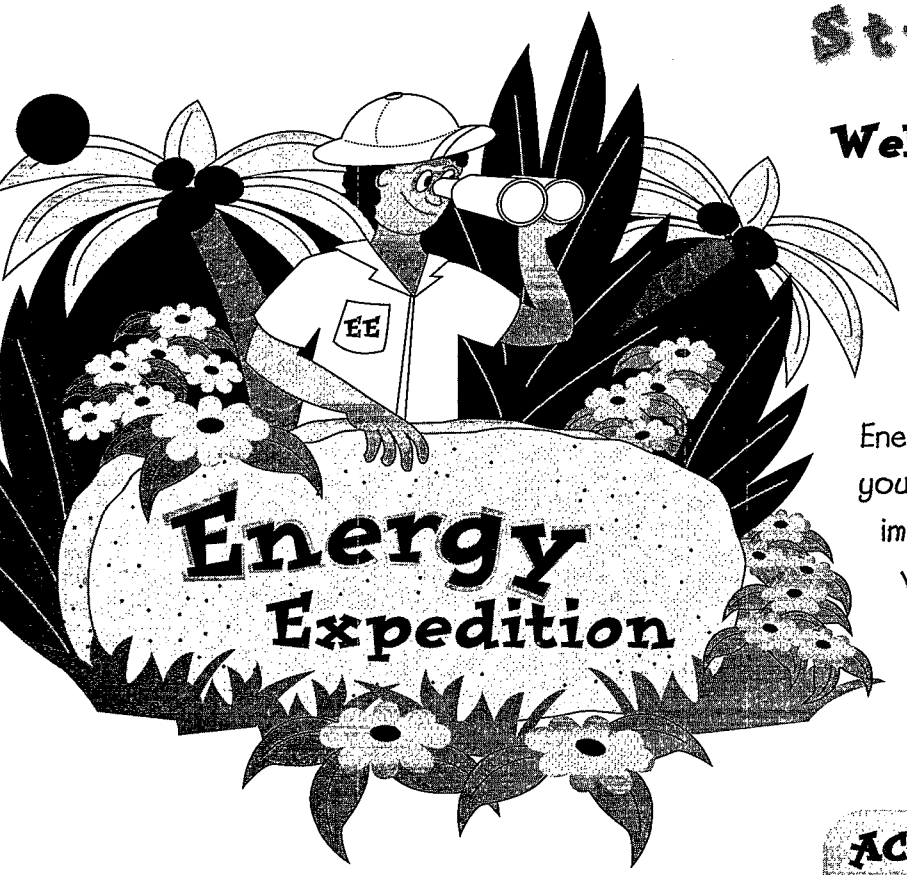
ACROSS

1. A type of energy. The word describes something that's "possible, but not certain." potential
4. The process of burning a material or substance. It's another word for "incineration," and its letters might "bust!" combustion
6. A liquid that we can control and direct to generate energy. You might drink it or swim in it. water
7. A substance that is neither liquid, nor solid, but can be removed from the Earth and used to generate power. gas
8. A hard, black substance that we burn for fuel. coal
10. A word describing energy from the sun. It rhymes with "polar." solar

DOWN

2. It's another word for unwanted material that you throw out into a container every day. You might set it out on the curb or throw it in a dumpster. trash
3. The hard rock-like remains of prehistoric animal and plant life, such as dinosaurs, which we sometimes discover in the Earth's crust. fossil
5. A natural gas that is generated by garbage decomposing in a landfill. Live animals can produce this gas as well...such as a cow burping! The word ends in "ane," but it's not "propane." methane
9. The liquid that we pump from the Earth's surface to burn for fuel. This work also applies to a product we often use in cooking. oil

Student Handout

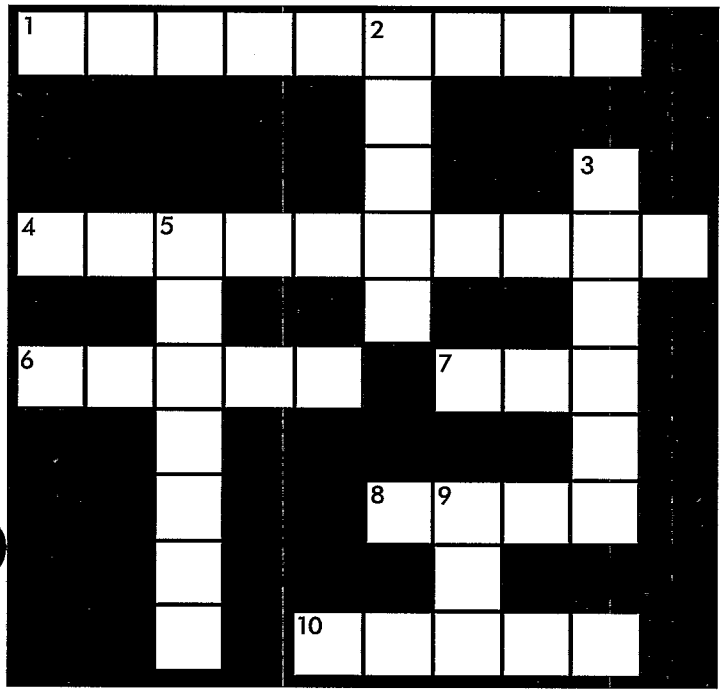


Welcome Energy Explorer!

You're about to set out on a mission to investigate ENERGY, including its uses, sources, and connection to our trash. If you accomplish your mission, you'll be promoted to an Energy Expert—and you'll be able to help your family and friends understand how important energy is to them and their way of life. This mission is not easy, however, and it will take all of your concentration and effort to crack the energy mystery. Good luck!

Name:_____

Directions: Your first task is to complete the Energy Crossword Puzzle below using the clues provided. Once you have filled in the crossword puzzle, you'll have a list of ten important energy vocabulary words.



ACROSS

1. A type of energy. The word describes something that's "possible, but not certain." _____
4. The process of burning a material or substance. It's another word for "incineration," and its letters might "bust!" _____
6. A liquid that we can control and direct to generate energy. You might drink it or swim in it. _____
7. A substance that is neither liquid, nor solid, but can be removed from the Earth and used to generate power. _____
8. A hard, black substance that we burn for fuel. _____
10. A word describing energy from the sun. It rhymes with "polar." _____

DOWN

2. It's another word for unwanted material that you throw out into a container every day. You might set it out on the curb or throw it in a dumpster. _____
3. The hard rock-like remains of prehistoric animal and plant life, such as dinosaurs, which we sometimes discover in the Earth's crust. _____
5. A natural gas that is generated by garbage decomposing in a landfill. Live animals can produce this gas as well...such as a cow burping! The word ends in "ane," but it's not "propane." _____
9. The liquid that we pump from the Earth's surface to burn for fuel. This word also applies to a product we often use in cooking. _____

Energy Story

Directions: Great job! You've now learned ten important energy vocabulary words! Read the story below to learn more about energy and become an Energy Expert. You must determine which of your ten vocabulary words goes in each blank. Remember, some words will be used more than once. After you have filled in all of the blanks, you'll have successfully completed your energy mission!

What is ENERGY?

Energy is one of the most important parts of our world—it makes things happen. Energy means the "ability to do work." Did you know that you use energy every day? Every time you flip a light switch on; use hot water; or ride in a car, bus, train, or plane, you are using energy. Each time you watch TV or use a computer, you are using energy. All of the clothes that you wear, toys you play with, and food you eat are products made from processes that require energy.

There are two different types of energy:

- Energy that is stored is called _____ energy.
- Energy that is moving is called kinetic energy.

Let your pencil rest on your desk. Right now, if it's not moving, your pencil has_____**(same as previous blank)** energy. Now, tap it lightly so that it rolls across your desk. Since it's moving, the pencil now has kinetic energy.

Where does ENERGY come from?

There are many different sources of energy on Earth and there are many different ways that we can tap into those sources and make the energy work for us—creating power, electricity, and heat.

One source of energy upon which we rely heavily are_____ fuels. How were these fuels formed? Millions of years ago, ancient plants absorbed the energy from the sun and converted it into more plants. Ancient animals, like dinosaurs, ate the plants and converted the plant's energy into body mass. When the animals and dinosaurs died, their remains collected in the ground, and, over millions of years, decomposed into a source of fuel.

What are some_____ **(same as previous blank)** fuels? Coal, oil, and natural gas are three important fuels that are derived from the Earth and the stored energy of organic remains.

_____ started out as a spongy, brown material called "peat," which consists of the decomposed organic matter of ancient animals and plants. Geologic forces buried the peat deep under the Earth's surface, where it was further packed down by heat and pressure. The compressed peat was eventually converted to_____**(same as previous blank)**.
We burn_____ **(same as previous blank)** to heat our homes and run electrical machinery. About 20 percent of the energy we use comes from _____**(same as previous blank)**.

_____ is formed deep within the Earth's surface in rocks that are fine-grained and rich in the organic remains of once-living animals. The oldest_____**(same as previous blank)** -bearing rocks date back more than 600 million years. _____ **(same as previous blank)** is burned to fuel vehicles and heat homes. About 45 percent of the energy we use comes from _____**(same as previous blank)**.

Natural _____ is a colorless, odorless fuel produced by drilling into the Earth's crust where it was trapped hundreds of thousands of years ago. Once it is brought to the surface, it is refined and purified to remove water, other gases, and sand. Next, it's transported through large metal pipelines that span the continent. Natural _____ **(same as previous blank)** is used for heating, cooling, and the production of electricity.

How is ENERGY connected to trash?

While these sources of energy continue to serve us well, they are known as nonrenewable resources that will eventually be used up. Once we use all of our supplies, we will have to depend on new sources of energy. We're already looking for new energy sources so that we can conserve those that come from within the Earth. That's where_____ comes in. Did you know that you can get energy from _____**(same as previous blank)**? There are two ways that we can use our_____ **(same as previous blank)** to make energy.

In one method,_____**(same as previous blank)** is taken to a waste-to-energy facility. These facilities burn the _____ **(same as previous blank)** during a process called_____. This process generates heat that can be converted to fuel and electricity. Waste-to-energy facilities take a large amount of trash and make it smaller by burning it. This reduces the amount of trash that piles up in our landfills, which is better for the environment.

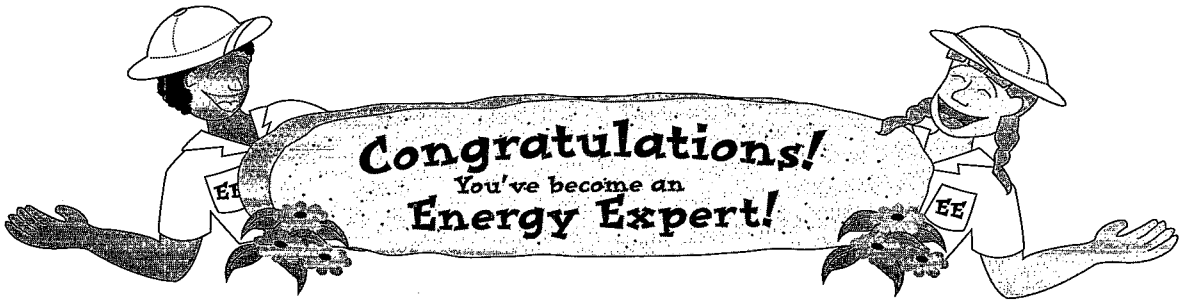
A second way for us to use trash for energy involves the garbage that we dispose of in landfills. As this trash decomposes, it produces _____ gas. Too often, this valuable source of energy is not used. Now, however, over 150 landfills in the United States are using the gas, captured by a special pipe system set up in the landfill, to generate electricity; provide fuel for factories, schools, and other facilities; and to produce natural gas for general distribution.

Are there any other sources of ENERGY?

In addition to using the energy we generate from our garbage, there are other ways we can harness the renewable energy sources that surround us. Here are two other important energy sources that we are just beginning to use in place of fossil fuels.

The light that comes to the Earth from the sun is pure energy. Nearly all other sources of energy originally got their energy from the sun. Organic matter, like plants, convert _____ energy into leaves, flowers, and fruits. We can also use energy from the sun to heat our homes and buildings with special _____ **(same as previous blank)** panels that capture and convert the light into energy.

Hydroelectric power is generated by harnessing _____. When _____ **(same as previous blank)** falls or runs downhill, it can be used to run turbines or large water wheels at mills and factories, which generate electricity.



Now you understand how our trash can help us generate power and electricity. In addition, you've learned all about our use of energy on this planet and the many different sources we can turn to for energy use in the future.

The Dirty Disposal Debate

social studies
language arts
science

Objective

To teach students about some of the environmental, social, and economic issues surrounding modern landfills.

Activity Description

Students will research and debate the pros and cons of using landfills for trash disposal.

Materials Needed

- Two 3- by 5-inch note cards for each student
- Internet, library, or encyclopedia access

Key Vocabulary Words

Landfill
Leachate
Ground water
Tipping fees
Decomposition
Methane

Duration

Day 1: 1 hour
Day 2: 1 hour

Skills Used

Research
Reading
Problem solving
Communication

Activity

Day 1

Step 1: Introduce the concept of the modern landfill and explain some of the advantages and disadvantages to this form of trash disposal. (Refer to the Teacher Fact Sheet titled *Landfills* on page 155 for background information and see the sidebar for helpful hints.)

Step 2: Hand out two note cards to each student and have them label one "Benefits" and the other "Concerns."

Step 3: As a homework assignment or an in-class group activity, have students conduct research and come up with one benefit and one disadvantage associated with landfills to write on their note cards. Encourage students

A Look at Landfills

Pros
- Gives us somewhere to put our trash.
- Is more sanitary than dumps of the past.
- Can generate methane gas that can be captured and used for energy.
- Can be capped and used for park land, playgrounds, even building sites.

Cons
- Causes loose garbage to be blown around.
- Can attract birds and pests.
- Can cause a lot of noise and traffic with trucks driving in and out.
- Has the potential to leak and contaminate ground water and soil.
- Can cause sinkage problems for builders who use capped landfills as foundations.

Journal Activity

Ask students to think about the advantages and disadvantages associated with landfills. Which one issue is most important to them? Why?

to use the school library, Internet, and adults as resources.

Day 2

Step 1: The next day, divide students into two groups. One group will use its note cards on the benefits of landfills and the other group will use their note cards on the concerns associated with landfills. Next, give each group 10 minutes to work together and prepare a debate on either the pros or cons of landfills. In those 10 minutes, ask the students to combine their note cards and assemble them in order of importance for easy reference during the debate. Instruct students to pick four classmates to represent the group as the debaters.

Step 2: Explain that each team will get 4 minutes to present their side of the debate. During that time, any of the four designated debaters for that team can speak, but they must take turns. After one side presents, the other team has 4 minutes to argue their points.

Step 3: After the debate, have the class discuss who had stronger points and why.

Assessment

1. Ask the students to decide whether or not they would want a landfill in their community. Why?
2. Have students list, from memory, three to four benefits and concerns associated with landfills.

Enrichment

1. Have students create a survey and conduct interviews with family members or friends to determine how other people feel about landfills. Compile, analyze, and discuss the results of the surveys in class. Make graphs or charts based on these results.
2. Take a field trip to a local landfill. Have kids tour the facility and learn how it works. When you return, have students write a paragraph on their visit, including five new facts about landfills that they learned.

The Trash Torch

social studies

science

math

Objective

To teach students about combustion and waste-to-energy facilities as a means of trash disposal, including how these facilites work and the related issues and concerns.

Key Vocabulary Words

- Combustion
- Incinerate
- Waste-to-energy
- Ash
- Air emissions

Activity Description

Students will calculate the weight and volume of trash before it is burned, observe the combustion process, and weigh and measure the ash that remains.

Duration

- 1 hour

Materials Needed

- One empty metal coffee can (16 ounces)
- One punch-type can opener
- One piece of wire mesh large enough to fit over the top of the can
- Five pieces of cardboard, 4 by 4 inches
- One roll of masking tape
- One scale
- Several pieces of garbage such as eggshells, orange rinds, napkins, and notebook paper (enough to fill the 4- by 4-inch box). Remember NOT to include anything like plastic, rubber, or products containing potentially hazardous chemicals
- One pack of matches
- One fire extinguisher
- One copy of the *Combustion Calculator* worksheet per student

Skills Used

- Computation
- Observation/classification

Activity

Step 1: For safety reasons, setup is extremely important for this activity. Make sure you:

- Choose an appropriate location outside the school for this activity. The location should be at least 100 feet from trees, buildings, and shrubs.
- Check with school/community administrators about any burning regulations or restrictions.
- Instruct students on proper safety behavior for the activity, including keeping a safe distance away from the fire at all times.

Journal Activity

Have students write a pretend newspaper story about a new combustion facility in their neighborhood. Where is it? How do people feel about it? What are the benefits and drawbacks?

Photocopy and distribute the *Combustion Calculator* worksheet to each student. (Refer to the Teacher Fact Sheet titled *Combustion* on page 159 for background information.) Introduce the following concepts to students:

—Combustion as a waste disposal method.

—Waste-to-energy facilities.

—Advantages and disadvantages to combustion and waste-to-energy facilities.

Step 2: Have student volunteers tape the pieces of cardboard together to form a small box or have them use small boxes you already have (to promote reuse). Have students weigh the box on the scale and record this number on their *Combustion Calculator* worksheets. Next, place the garbage in the box. Have students weigh the box with the garbage and record this number on their worksheets. Then, ask students to calculate the weight of the garbage based on these two figures.

Step 3: Next, have two or three student volunteers use a ruler to measure the length, width, and height of the box. Ask students to record these numbers, calculate the volume of the garbage in the box, and record this number on their *Combustion Calculator* worksheets. Ask students to predict how these numbers will change after the garbage has been combusted. Have them record their predictions on their worksheets.

Step 4: Take the class outside to your preselected experiment location. Use the masking tape to make a line on the ground designating a "safety zone" (8 to 10 feet from the coffee can) behind which students can safely watch the experiment. Remind students that this experiment should be conducted by adults only and should NOT be attempted at home.

Step 5: Use the punch-type can opener to punch several holes around the bottom of the coffee can. Explain that this will allow oxygen to enter the can and assist the burning process. Pour the trash from the cardboard box into the can, and light the contents on fire. Immediately place the wire mesh over the top and step back behind the "safety zone" line with students. The mesh will keep the burning trash safely contained in the coffee can. Have students observe what they see, smell, or feel and record these thoughts on their worksheets.

Step 6: After the trash has finished burning and the can and contents have completely cooled, place the remaining ashes back into the cardboard box and have new student volunteers weigh them and record the results. Ask the students to observe the difference in volume of between the garbage and its ash.

Assessment

1. Ask students to think about what happened during the combustion process and explain how this method of trash disposal saves landfill space. What changed in terms of weight and volume?
2. Have students complete the math word problems on their worksheets.
3. Ask students to explain how this method of trash disposal might generate energy. Did they observe any evidence of energy being created during the experiment?
4. Ask students to list any problems they observed that might be associated with combustion. What was in the smoke that was emitted to the air? Ask students what might have happened if rubber or plastic had been burned?

Enrichment

1. If possible, visit a waste-to-energy facility on a field trip. Have students write essays about the visit when they return. Or, invite a guest speaker to talk about waste-to-energy facilities (a county manager, a county engineer, or a local solid waste officer).
2. Investigate the role that oxygen plays in combustion by repeating the experiment using another coffee can that does not have holes punched in the bottom. You might also reuse the first can with various amounts of trash to investigate the most efficient combination of air and fuel for complete combustion.
3. Contact your solid waste department for information about how much trash is burned at combustion facilities across the country per year. Also find out how much ash is produced from this combustion. Have the students create charts that show the difference in the amount of waste (trash versus ash) headed to landfills.

Name: _____

Combustion Calculator

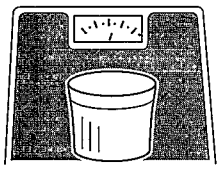
Trash

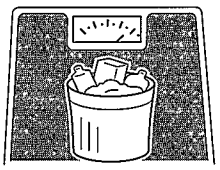
Weight of box = _____

Weight of trash + box = _____

Weight of trash = _____

Volume of trash in box = _____
(Volume = length x width x height)





My predictions for after the trash is burned:

Weight of trash= _____

Volume of trash in box = _____

Combustion

My observations during the experiment:

_____

_____

_____

_____

_____

_____

_____

Ash

Weight of ash + box = _____

Weight of ash = _____

Volume of ash in box (estimate) = _____

Reduction of trash through combustion:

Volume of trash ____ - Volume of ash _____ = _____

Combustion Word Problems

Every year, each of us generates about 1 ton of garbage. One person's yearly garbage fills 27 large garbage cans.

1. When 1 ton of garbage is combusted in a waste-to-energy facility, we recover 500 kilowatt hours of energy. Assuming electricity costs 7 cents per kilowatt hour, how much is the energy contained in 1 ton of garbage worth? _____

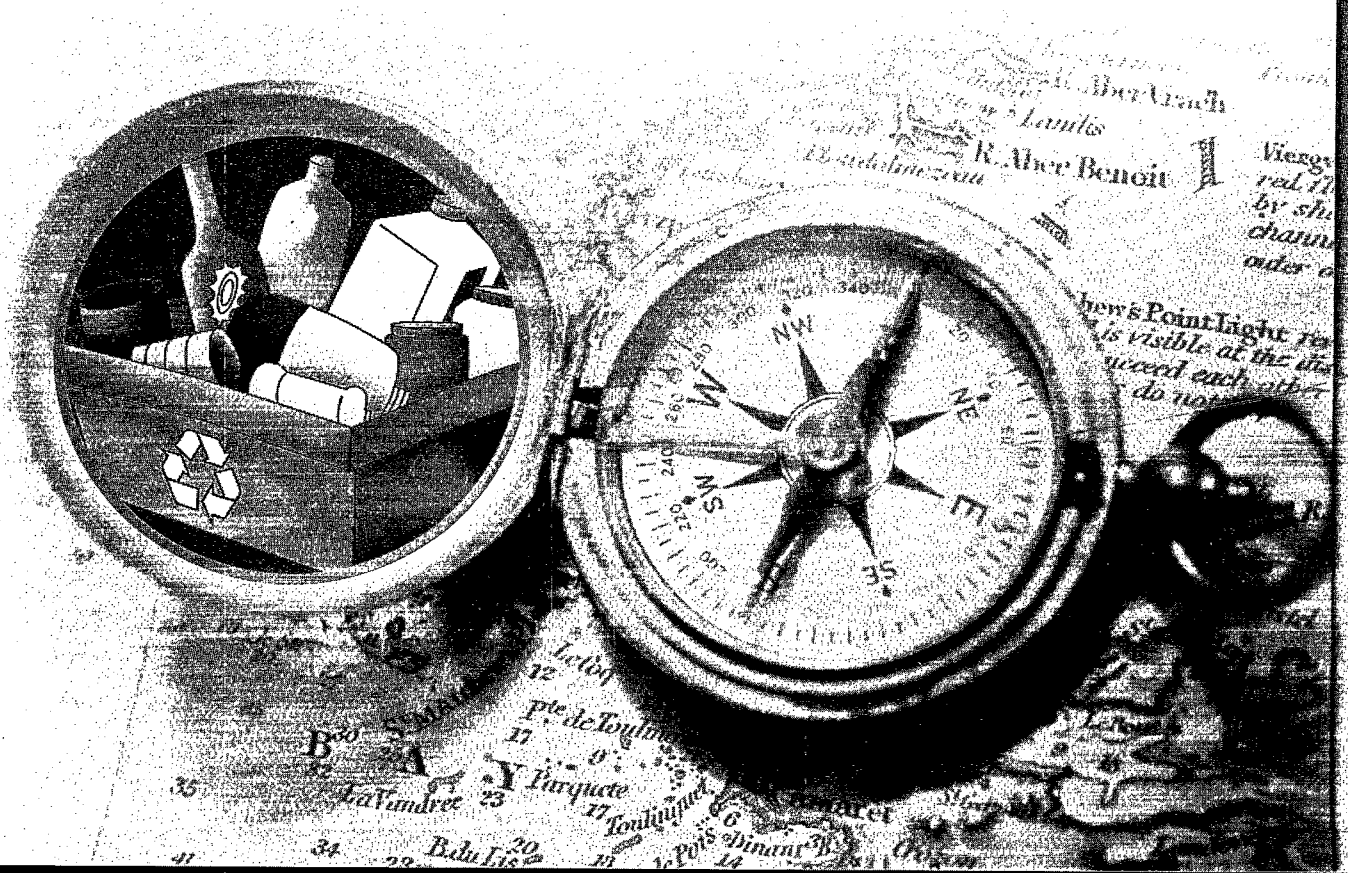
2. As we learned in question #1, 1 ton of garbage contains 500 kilowatt hours of energy. This amount of energy can light a lamp for 5,000 hours. How many hours could you light a lamp if you had the energy contained in 42 tons of garbage? _____ How many days? _____ How much money is this amount of energy worth? _____

UNIT 3

Putting It All Together

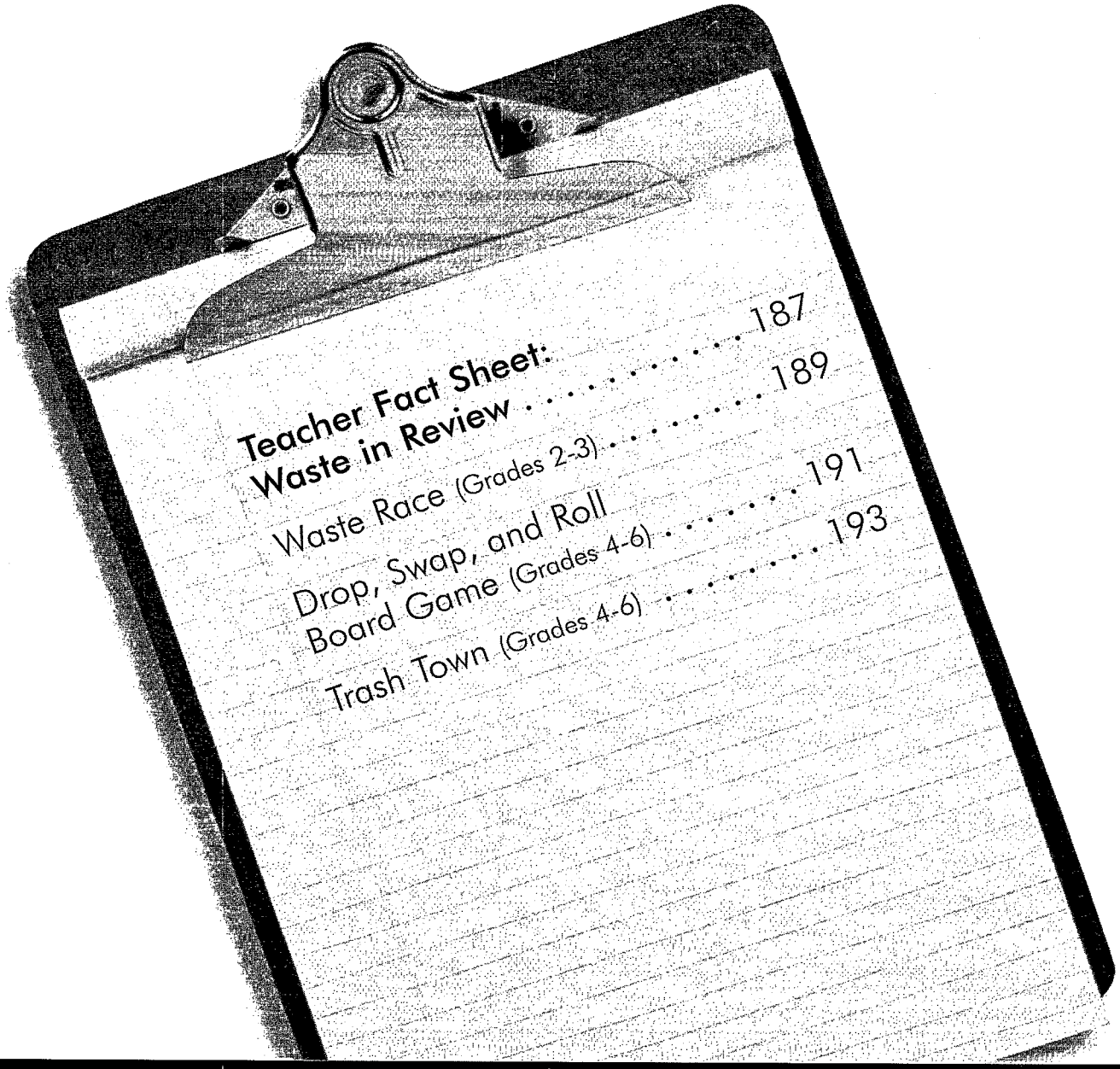
Integrating the Different Solid Waste Options

Once students understand the range of available solid waste management options—including their different purposes, benefits, and impacts—they are ready for a series of activities that utilize and reinforce their accumulated knowledge. This unit allows students to integrate the key lessons learned from previous sections and exercise decision-making and analytical skills while having fun.



CHAPTER 1

Waste in Review



Grade • Subject • Skills Index

Activity Name	Waste Race	Drop, Swap, and Roll Board Game	Trash Town
Grade Range			
K			
1			
2	✔		
3	✔		
4		✔	✔
5		✔	✔
6		✔	✔
Subjects Covered			
Math		✔	✔
Science	✔	✔	
Language Arts		✔	
Social Studies	✔	✔	✔
Art			
Health			
Skills Used*			
Communication	✔	✔	
Reading		✔	✔
Research			
Computation		✔	✔
Observation/ Classification	✔	✔	
Problem Solving			✔
Motor Skills	✔	✔	

*See Glossary of Skills for more details.

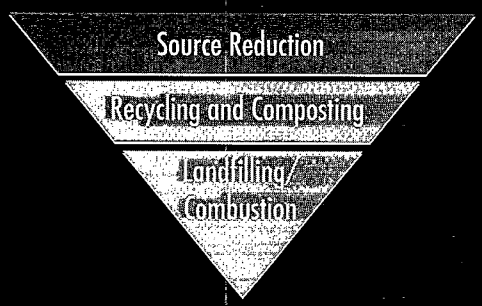
Waste in Review

Integrating all the waste management methods described in this resource has helped a growing number of communities and industries divert or reduce significant quantities of garbage from the waste stream. Successful integrated programs not only make waste management more cost-effective, but they create jobs and may even provide an economic boost to communities. Because no one method can manage all the nation's garbage, EPA recommends a waste management hierarchy that ranks the various strategies in order of priority.

EPA's Solid Waste Management Hierarchy

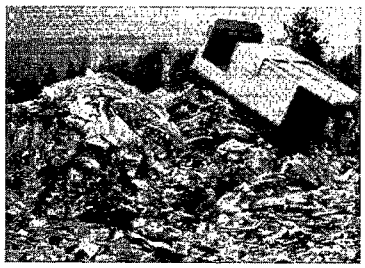
- Source Reduction—preventing waste is the best way to manage it!
- Recycling and Composting—converting waste into new and valuable products prevents pollution (including harmful greenhouse gases), saves natural resources, and conserves valuable landfill space.
- Landfills and Combustion—land disposal and combustion in properly managed facilities and in compliance with environmental regulations are options for the remaining waste. Energy can be generated from each of these approaches.

Solid Waste Hierarchy



Waste Generation

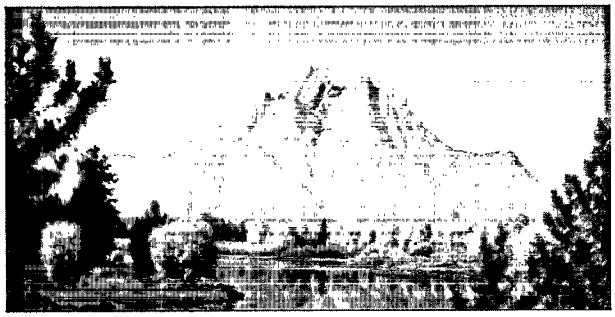
Waste is generated at all points in a product's life cycle—while harvesting natural resources, during design and production, and during and after use in homes, offices, and schools. Hazardous wastes, which are substances that are toxic, ignitable, corrosive, or reactive, are most often generated during extraction or production of a product, but can also come from households in the form of leftover products such as bug sprays, turpentine, motor oil, and laundry bleach. Municipal solid waste, such as old newspapers, yard clippings, empty bottles, and even whole appliances, is generated by people's everyday use of products, packaging, and materials. In the United States, each person generates nearly 4.5 pounds of solid waste per day. This figure could be reduced by placing more emphasis on source reduction.



Helping Communities' Quest for Less

Regardless of a community's size or municipal solid waste service, progress toward preferred waste management approaches can only work if individuals understand and practice the 3 R's—reducing, reusing, and recycling the solid waste they generate each day. Every member of the community can do their part by identifying

ways to prevent and recycle waste and to safely dispose of household hazardous waste. It is also important for individuals and companies to "buy recycled." After all, if no one buys recycled-content products, there's no way to close the recycling loop.



Future Goals

During the 1990s, recycling in the United States increased from 16 to 28 percent. EPA's goals for the future are to recycle 35 percent of the municipal solid waste generated by 2005; to reduce waste generation to 4.3 pounds per person per day; to empower state, local, and tribal governments to better manage solid waste; to provide leadership in source reduction and recycling; to build stronger public and private partnerships; and to ensure the environmental soundness of source reduction, recycling, combustion, and landfill disposal. The concepts learned from the activities in this resource will help lead the nation to the path of a sustainable and waste-free future.

Additional Information Resources:

Visit the following Web site for more information on all the topics discussed in this resource:

- U.S. Environmental Protection Agency (EPA) Office of Solid Waste: <www.epa.gov/osw>

Waste Race

science

social studies

Objective

To classify trash items as reusable, recyclable, compostable, disposable, or household hazardous waste.

Activity Description

Students will participate in a relay race to place trash items in appropriate bins.

Materials Needed

- A variety of trash items in each of the categories listed in Step 1, supplied by the teacher (see below for suggestions)
- Two trash bags or wastebaskets
- Two sets of colored stickers (e.g., red and blue)
- Five large plastic or metal bins

Waste Race Suggested Items (no food items please)

Napkin	Steel can	Paper lunch bag
Plastic packaging	Plastic fork	Cardboard
Piece of cloth	Aerosol can	Paint can
Glass bottle	Piece of wood	Teabag
Aluminum can	Copy paper	Coffee can
Leaves or grass	Text book	Flowers

Key Vocabulary Words

Reusable
Recyclable
Disposable
Compostable
Household hazardous
Waste

Duration

50 minutes

Skills Used

Communication
Observation/classification
Motor skills

Activity

Step 1: Review the Teacher Fact Sheets titled *Solid Waste* on page 41, *Hazardous Waste* on page 45, *Recycling* on page 73, and *Composting* on page 109 for background information. Review the different waste management options with students to put the activity in context. Discuss the different collected trash items and where they should go when they are done being used (e.g., trash, recycling bin, compost pile).

Step 2: Label five plastic bins/trash cans as "Reusable," "Recyclable," "Compostable," "Household Hazardous Waste (HHW)," or "Disposable Waste," respectively, and place them throughout the room. (This activity will work best in a large area like a gymnasium or a playground so the students have enough room to run around.) Review vocabulary with students.

Step 3: Collect trash items over a few days (see above for suggestions). Collect enough for each student to have at least one turn participating in the race. Make sure the items are not dangerous for the students to handle (e.g., no sharp edges on open cans) and they should be cleaned, if necessary. Divide the items into two piles (one for each team), labeling the Red team's items with the red stickers and the Blue team's items with the blue stickers.

Step 4: Have students form two lines/teams in the center of the room.

Step 5: Explain to the students how a relay race works. The teacher should pre-determine and announce a time limit for the race, based on the number of students and their level of familiarity with the subject. When the teacher signals for the race to start, the first student in each line will reach into his or her team's trash bag and pull out an item. The two students will decide in which bin it belongs and run to the labeled plastic bin. After placing the trash item in the bin, the student will run back to the end of the line and the next two students will repeat the same process. When the time limit has been exceeded, the teacher will end the race. The object is to be the fastest team to sort the items correctly.

Step 6: At the end of the race, empty each bin one at a time so all the students can see if the items were placed correctly. Encourage the students to discuss why each trash item was placed in its bin. Discuss whether some trash items can be placed in more than one bin. The team that was able to place the most items in the correct bin wins.

Assessment

1. See Step 6.
2. Have students name an item not included in the game that is reusable, recyclable, compostable, disposable, and/or household hazardous waste.

Enrichment

1. Expand the Waste Race to include other classrooms and possibly a tournament for a great Earth Day activity.
2. Explore the activities found in the Planet Protector's Club kit. This kit was created by EPA as a way to get students involved in learning about their environment. It includes two pocket guides (one for adults and one for children), an official membership certificate, an official Planet Protectors Club badge, activity guides for grades K-3 and 4-6, a board game about recycling, and a Planet Protectors Club poster. To order this kit, call EPA at 800 424-9346 and ask for document number EPA530-E-98-002.

math

science

language arts

social studies

Drop, Swap, and Roll Board Game

Objective

To educate students about recycling, composting, reuse, household hazardous waste, landfilling, and combustion.

Activity Description

Students play a board game in which they must get rid of their "trash" cards by dropping off items at appropriate bins (e.g., recycling, composting, or reuse bins) stationed on the playing board. Students learn facts about waste management as they move around the board.

Materials Needed

- Several *Drop, Swap, and Roll* playing boards, with the included "trash" and "trash trivia" cards and playing pieces.
  Call EPA at 800 424-9346 to order this game at no cost while supplies last (document number EPA530-E-98-002).
- Several dice (one for each game board).

Key Vocabulary Words

- Reuse
- Recycling
- Composting
- Landfill
- Incinerator
- Household hazardous waste

Duration

1 hour

Skills Used

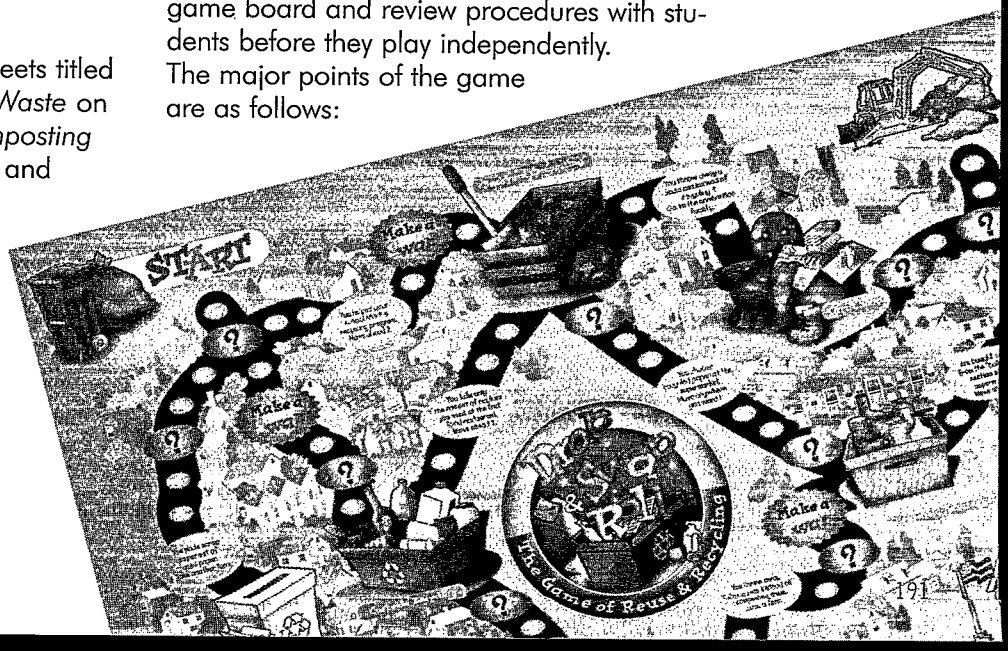
- Communication
- Reading
- Computation
- Observation/classification
- Motor skills

Activity

Step 1: Review the Teacher Fact Sheets titled *Solid Waste* on page 41, *Hazardous Waste* on page 45, *Recycling* on page 73, *Composting* on page 109, *Landfills* on page 155, and *Combustion* on page 159 for background information on the different waste management options. Review vocabulary with students.

Step 2: Divide class into groups of 4 to 6 students and distribute one game board (including cards, playing pieces, and dice) to each group.

Step 3: Read instructions provided with game board and review procedures with students before they play independently. The major points of the game are as follows:



Journal Activity

Ask students to think about how they would design their community's waste management system. What would they include? How would it be different from the system their community has in place now?

Each player starts with 10 "trash" cards. A player rolls the die and moves backward or forward on the board to dispose of his or her "trash" cards in the appropriate places. Refer to the legend on the board to determine which items go where. (Some trash items might not be recycled in your community or might be handled differently than the game suggests. Explain to the students that this game can help them learn about things that are recyclable, even though they are not necessarily recycled locally.) The first player to get rid of all his or her "trash" cards is the winner.

Step 4: Players who land on a space with a question mark (?) must answer a true/false question from the "trash trivia" cards. If the player answers the question correctly, he or she gets to roll again. If he or she answers incorrectly, he or she must take another trash card from the center of the board. (The answers to some "trash trivia" cards might not reflect the practices in your community. These cards can be removed or replaced by more appropriate cards that the teacher or students can create.)

Step 5: If a player lands on a space that says "Make a Swap," he or she can get rid of any "trash" card by trading it for one from another player. Refer to the game rules for more details.

Step 6: If one player thinks another player dropped off an item at a particular location incorrectly, the first player can challenge the other player. First, check the legend to settle the dispute. If the player did drop off an item incorrectly, that player must take back his or her card and miss that turn. If that player was correct in dropping off the item (and the challenger was wrong), then the challenger must answer a "trash trivia" question. If the challenger answers incorrectly, he or she must take another "trash" card. If he or she answers correctly, the game proceeds as before. Refer to the game rules for more details.

Assessment

1. Ask students to list three items not found in the board game that can be recycled, reused, or composted in your community.
2. Have students explain why the game penalizes players by sending them to the landfill or combustor.
3. Ask students why household hazardous waste has its own station.

Enrichment

1. Ask the students to explore the different activities found on EPA's Office of Solid Waste Web site for kids <www.epa.gov/epaoswer/osw/kids.htm>. Activities include numerous games, a comic book, and a coloring book.
2. Explore the other activities found in the Planet Protector's Club kit, which is available at no cost from EPA. This kit was created by EPA as a way to get students involved in learning about their environment. In addition to the *Drop, Swap, and Roll* board game, it includes an official membership certificate, an official Planet Protectors Club badge, activity guides for grades K-3 and 4-6, and a Planet Protectors Club poster. To order this kit, call EPA at 800 424-9346 and ask for document number EPA530-E-98-002.

Trash Town

math

social studies

Objective

To teach students about the costs involved in waste management.

Key Vocabulary Words

- Landfill
- Tipping fee
- Recycle
- Disposal

Activity Description

Students will read the summary information about Trash Town and complete math problems to assess the cost of disposal and recycling in Trash Town.

Duration

1 hour

Materials Needed

- One copy of *Trash Town* worksheet per student
- One pencil per student
- One calculator per student (optional)

Skills Used

Reading
Computation
Problem solving

Activity

Step 1: Photocopy and distribute the *Trash Town* worksheet to each student. Introduce the following concepts to your class (refer to the Teacher Fact Sheet titled *Solid Waste* on page 41 for more information):

- It costs us money to dispose of our garbage. The more garbage we generate, the more money we pay for disposal.
- Landfills charge a fee for accepting trash (tipping fee).
- We can save money by recycling, composting, reusing, or source reducing instead of throwing out garbage.
- We can earn money by recycling because recycled materials can be sold to manufacturers.

The Economics of Trash

- Landfill Tipping Fee—Communities that want to dispose of their waste in a landfill must pay the landfill owners a fee, based on the number of tons of waste they discard.
- Recyclables Market—Recycling can be profitable! Communities that collect recyclable items can sell those items to manufacturers for reuse. Communities can check the recyclables marketplace to find out the current, per-ton prices associated with different recyclabe materials.

Step 2: Pass out calculators to each student. Ask the students to carefully read the *Trash Town* worksheet and complete the math problems related to the town's disposal and recycling practices. (Teachers can decide whether this worksheet should be completed in groups or individually.)

Journal Activity

Ask students to pretend that they are the mayor of Trash Town. If the residents of their town complained about the price of garbage disposal, what would they tell them?

Assessment

1. Collect the *Trash Town* worksheets and evaluate the computations and answers.
2. Ask students to identify the most expensive element of garbage disposal. Ask them whether it's more costly to recycle and reuse or to throw everything away.
3. Ask students to list some of the cost considerations involved in garbage disposal.

Enrichment

1. Conduct a "Pay-As-You-Throw" (PAYT) experiment in the classroom or lunchroom. Hand out the same amount of fake money to each student and charge them based on the amount of trash they throw away from their lunch. (One paper bag=$100, one plastic bag=$200, one aluminum can=$500, etc.) Keep this up for a few days and see if the students can bring in lunches that are less costly the next day (less wasteful). See who ends up with the most fake money at the end of the week and give that person a prize for being "waste wise." You can also explain to students that more than 4,000 communities across the country have PAYT programs where citizens are charged based on the amount of garbage they throw away.
2. Contact your local solid waste agency to obtain actual waste statistics and costs for your own community. Have students use these numbers to find out how much money the community spends on garbage disposal per day, per week, or per year.
3. Have students devise a plan for helping the residents of Trash Town save more money and protect the environment. Ask the students to write a speech or article explaining their new plan to the residents of Trash Town—what needs to be recycled and how, how the residents will benefit, and how the environment will benefit.

Answer Key

1. How many tons of garbage does the entire Trash Town generate per day? 110 tons

Per year? 40,150 tons

2. How much does it cost for Trash Town to throw all of its garbage into a landfill each year? $1,606,000

3. If Trash Town started a recycling program and recycled 30 percent of its garbage each year, how many tons of recyclables would be collected? 12,045 tons

4 If Trash Town recycled 30 percent of its garbage per year, how many tons of trash would still be sent to the landfill? 28,105 tons

5. How much money (in less tipping fees) would Trash Town save from recycling 30 percent of its garbage per year? $481,000

6. How much money would Trash Town earn from recycling 30 percent of its garbage per year? $120,450

7. How much could Trash Town earn if it started recycling 50 percent of its garbage per year? $200,750

What about 60 percent? $240,900

Welcome to Trash Town

Greetings! I'm Ruby Rubbish, the mayor of Trash Town, and I want to thank you for visiting our community. Are you good with numbers? Do you know what's best for the environment? We need your help! The residents of Trash Town are spending lots of money to haul and dump their garbage in the local landfill. Our landfill is filling up fast, and we worry about what all this trash is doing to our environment. Plus, we can't afford to keep paying so much for our garbage disposal. We've heard that other towns are helping to protect the environment by recycling and reusing items instead of throwing them away. We've also heard that some communities can make money by recycling. Unfortunately, the Trash Town garbage specialist is on vacation and we need someone to answer all of our questions about garbage disposal immediately. If I give you all of the information, can you help? If you can figure out the solutions to our questions on the next page, you'll be the hero of Trash Town!!

Trash Town Trivia

Population: 50,000

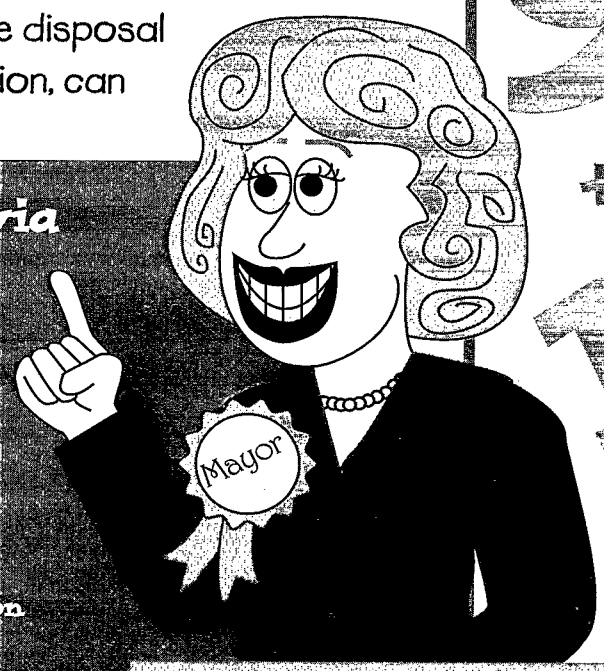
Garbage generated by each Trash Town resident per day: 4.4 pounds

Tipping fee for garbage dumped at local landfill: $40/ton

Money earned for collecting recyclables: $10/ton

Other important information

1 ton = 2,000 pounds
1 year = 365 days



Trash Town

Student Handout

Name:_____

1. How many tons of garbage does the entire Trash Town generate per day?

_____

Per year?

_____

2. How much does it cost for Trash Town to throw all of its garbage into a landfill each year?

_____

3. If Trash Town started a recycling program and recycled 30 percent of its garbage each year, how many tons of recyclables would be collected?

_____

4. If Trash Town recycled 30 percent of its garbage per year, how many tons of trash would still be sent to the landfill? _____

5. How much money (in less tipping fees) would Trash Town save from recycling 30 percent of its garbage per year?_____

6. How much money would Trash Town earn from recycling 30 percent of its garbage per year?

_____

7. How much could Trash Town earn if it started recycling 50 percent of its garbage per year?

_____

What about 60 percent? _____

CHALLENGE CORNER

Can you face the Trash Town challenge? The following information will help you solve the word problems below.

Different types of recycled materials earn different amounts of money in the recyclables marketplace. For example:

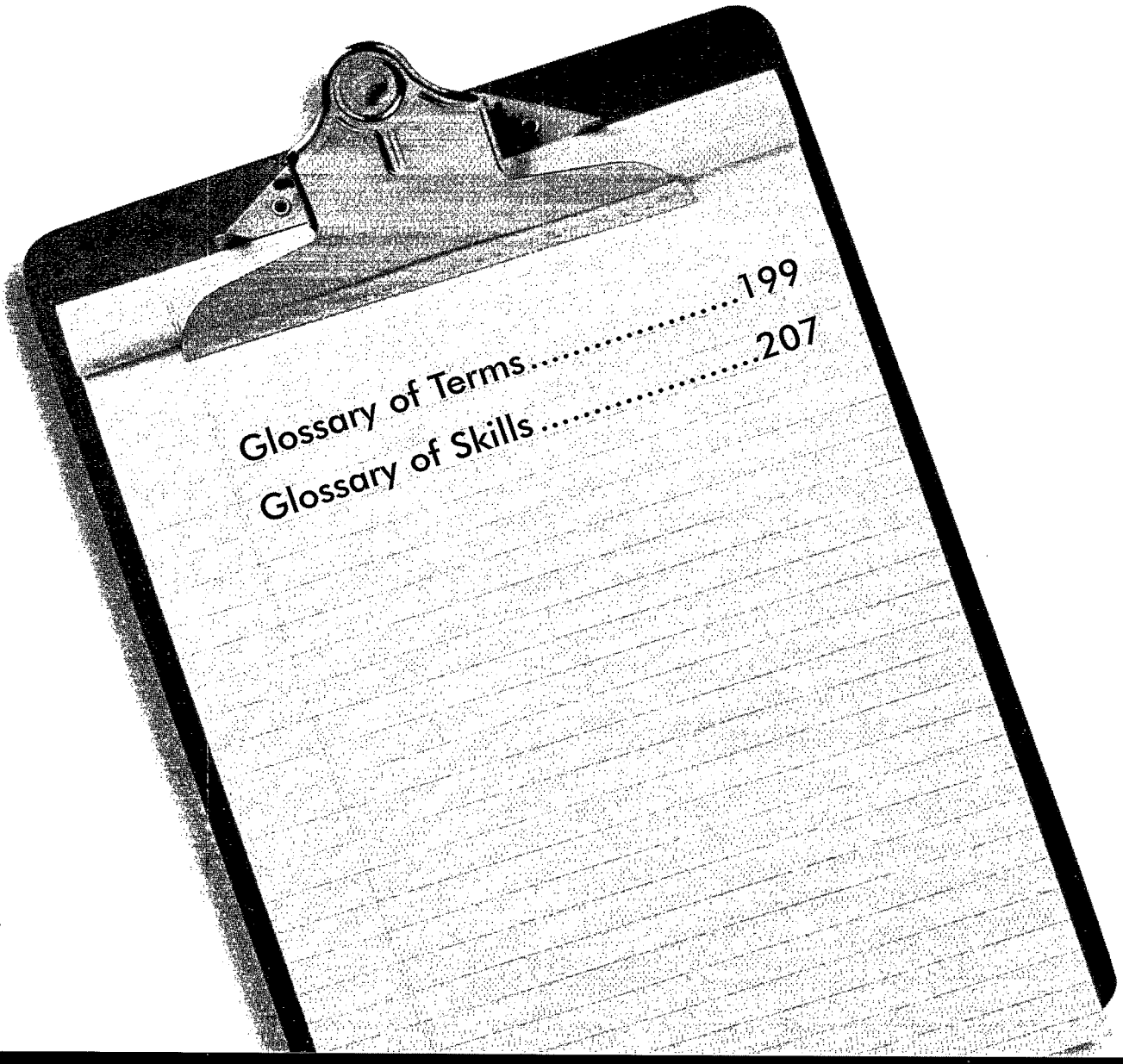
Plastic bottles: $15/ton	Cardboard: $40/ton	Magazines: $5/ton	Steel: $40/ton
Aluminum cans: $40/ton	Newspaper: $15/ton	Glass: $15/ton	

1. How much money would Trash Town earn for recycling 250 tons of newspaper and 30 tons of steel per year? _____

2. If Trash Town recycles 20 percent of its total annual garbage and 15 percent of that garbage is aluminum cans and 5 percent is magazines, how much money will it earn in total? _____

3. How many pounds of cardboard would Trash Town have to recycle in order to earn more than $39,000 per year? _____

Glossary



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Glossary of Terms

Note: This glossary defines unfamiliar terms specifically related to solid waste and the environment; some words listed in the activities under "Vocabulary" will not be found in this glossary.

A

Aerobic—with oxygen. During the composting process, certain bacteria need oxygen to break down the mix of organic materials. This is known as aerobic decomposition.

Anaerobic—without oxygen. In a landfill, certain bacteria decompose organic materials without oxygen and create methane gas through a process known as anaerobic decomposition.

Ash (also **combustion ash**)—solid residue that remains after the combustion, or burning, of waste.

B

Backyard composting—the homeowner's practice of collecting leftover kitchen scraps (excluding meats and fats) and yard trimmings for decomposition in a private compost pile. Backyard composters can use their compost as a soil enhancement for their gardens.

Bacteria—single-celled microorganisms. Certain types of bacteria break down organic materials (using an ***aerobic*** and/or ***anaerobic*** process).

Bedding—organic material, such as shredded newspaper, used to retain moisture and allow proper air circulation and drainage to provide a healthy environment for worms in a ***vermicomposting*** container.

Biodegradable—materials that can ***decompose***, usually by bacteria or sunlight, into basic components. Most organic materials (paper, grass clippings, food scraps), under the right conditions, are biodegradable.

Biodiversity (also **biological diversity**)—indicated by the numbers of different species of plants and

Common Recyclable Items and Related Terms

Aluminum—a lightweight, silver-white, metallic element that makes up approximately 7 percent of the Earth's crust. Aluminum is used in a variety of ways, but perhaps most familiarly in the manufacture of soft drink cans.

Bauxite—a rock in which aluminum is found in high concentrations.

Cardboard—a thin, stiff material made of paper pulp and used in making cartons and other forms of packaging.

Cullet—clean, generally color-sorted, crushed glass used to make new glass products.

Fibers—the long, thick-walled cells that give strength and support to plant tissue. The fibers of wood and cloth are used in making paper.

Glass—hard, brittle, generally transparent or translucent material typically formed from the rapid cooling of liquefied minerals. Most commercial glass is made from a molten mixture of soda ash, sand, and lime.

Metal—an element that usually has a shiny surface, is a good conductor of heat and electricity, and can be melted down, fused, or hammered. Metals include iron, gold, sodium, copper, magnesium, tin, and aluminum.

Paper—a thin material made of pulp from wood, rags, or other fibrous materials and used for writing, printing, or wrapping.

Plastic—a material made from petroleum capable of being molded, extruded, or cast into various shapes. There are many different kinds of plastic made from different combinations of compounds.

Pulp—a mixture of fibrous material such as wood, rags, and paper, that is ground up and moistened to be used in making paper or cardboard.

Steel—a strong, durable material made of iron and carbon, and often other metals, to achieve different properties. Steel is often used as a component in cans and as a structural material in construction.

Tin—a soft silver-white metallic element, capable of being easily molded and having a low melting point. Tin is often used together with other metals in making cans for packaging.

animals found in a natural environment. Many different species of plants and animals within an ecosystem is indicative of a healthy environment.

Brownfields—abandoned or unused industrial and commercial land that cannot be developed or expanded because of real or perceived contamination with toxic substances.

Bulk—when food or other products are sold unpackaged or in large volumes to reduce packaging waste. Consumers who buy one large bottle of juice rather than many small containers of juice, for example, are "buying in bulk."

Byproduct—excess material or waste produced in addition to the primary product. Sludge is a byproduct from the manufacture of paper, for example. Many manufacturers look for innovative ways to reuse or recycle the byproducts created during the production process to reduce waste.

C

Castings—manure from red wriggler worms that can be used as a soil conditioner to provide aeration, drainage, and nutrients to soil.

Climate—the average course or condition of weather over a period of years based on conditions of heat and cold, moisture and dryness, clearness and cloudiness, wind and calm, applied to a specific location or globally. Southern Florida, for example, has a sunny, dry, warm climate.

Closing the loop—purchasing products made from recycled materials. Recycling is a cycle. It is not enough simply to collect recyclables for manufacture into new products. People must then buy products made with recycled content, thus closing the loop.

Combustion/Incineration—a rapid chemical process that produces heat, gas, ash, and usually light through burning. This process is one option for the *disposal* of *municipal solid waste*. It can also be used as a treatment or disposal option for hazardous waste. See *combustor*, *waste-to-energy*.

Combustor/Incinerator—a facility for the controlled burning of waste. Burning municipal solid waste can reduce its volume and weight. Some facilities capture energy from the steam or heat that is produced during the burning process. (See *waste-to-energy*.) Burning hazardous waste can be considered a form of treatment and can reduce the hazardous components of the waste.

Compaction—the act or process of pressing materials together to occupy the smallest volume possible; a common practice at a *sanitary landfill*.

Compost—a crumbly, earthy, sweet-smelling mixture of decomposing organic matter (e.g., leaves, food scraps) created in a controlled, *thermophilic* environment that is often used to improve the texture, water-retaining capacity, and aeration of soil.

Composting—the controlled biological decomposition of organic material under *aerobic* or *anaerobic* conditions. Organic materials are broken down (*decomposed* by microorganisms) into compost, also known as *humus*. Composting can occur in a backyard bin, a pile, long *windrows*, or in a *vermicomposting* container.

Conservation—the protection or wise use of natural resources that ensures their continuing availability to future generations; the intelligent use of natural resources for long-term benefits.

Consumption—the amount of any product or resource (e.g., material or energy) used in a given time by a given number of consumers.

Contamination—the process of adding one substance to another substance, such as as motor oil to water, that reduces its quality; to make impure or unsafe by contact with potentially harmful substances.

Corrosive—a substance capable of dissolving or breaking down other substances (especially metals) or causing skin burns. A corrosive has a *pH level* below 2 or above 12.5.

D

Decompose—to break down into basic components, given the right conditions of light, air, and moisture; refers to materials such as food and other plant and animal matter.

Deforestation—the clearing and removal of trees from a forested area.

Disposable—products or materials that can be or are usually thrown away after one use or a limited amount of time. For example, used paper plates are disposable.

Disposal—refers to the process of throwing away unwanted materials. These materials are placed in a landfill or combusted rather than recycled, reused, or composted.

Disposal cell—a fixed area in a ***sanitary landfill*** where waste is disposed of, compacted into the smallest space possible, and then covered with soil on a daily basis.

Durable—goods that can be used more than once and withstand long use, wear, and decay. Appliances are examples of durable goods.

Dump—site where waste is disposed of in an unmanaged, uncovered area. Current landfill restrictions have made dumps illegal. See ***sanitary landfill***.

E

Ecosystem—community of plants and animals that interact with one another and with the surrounding nonliving environment. Examples of ecosystems include ponds, forests, and beaches.

Effluent—waste material discharged into the environment; refers to the treated liquid ***emitted*** from a manufacturing facility or municipal wastewater treatment plant.

Emission—the discharge of gases or particles, such as from a smokestack or automobile engine.

Energy—capacity for a system or an object to do work (i.e., cause a change by pulling, pushing, or heating). Energy generated from ***incineration***, for example, can be harnessed to provide electrical power for communities.

Environment—the external conditions that influence the development and survival of an organism or population; usually refers to air, water, land, plants, and animals.

Environmental impact—the effect of an activity or substance on the environment.

Environmentally preferable products—those products that have a reduced effect on human health and the environment when compared to other products that serve the same purpose. For example, products that contain recycled content, require less energy or create less waste during production and manufacture, use less packaging, or are reusable or recyclable are preferable.

F

Flammable—describes a substance that ignites and burns.

Food chain—the transfer of food energy from one organism to the next. As one example of a simple food chain, an insect consumes a plant and is then consumed by a bird.

Food web—the complex and interlocking networks of ***food chains*** within ecosystems where plants and animals coexist and depend on one another for energy needs.

Fossil fuels—fuels such as petroleum or coal formed over millions of years from the remains of ancient organic materials.

G

Geothermal energy—the internal heat of the earth collected from underground concentrations of steam or hot water trapped in fractured or porous rock.

Global climate change—natural or human induced change in the average global temperature of the atmosphere near the Earth's surface. This condition poses serious dangers around the world, potentially prompting such disasters as flooding, drought, and disease.

Grasscycling—refers to a method of ***source reduction*** whereby grass clippings are left on the lawn rather than bagged and set out for collection.

Greenhouse effect—the excessive trapping of heat in the Earth's atmosphere by a blanket of gases. Gases such as water vapor, methane, and carbon dioxide exist naturally and help retain the Earth's normal surface temperature. Changes in the normal volume of gases in the atmosphere, due to human-induced activities, are believed to contribute to ***global climate change.***

Greenhouse gas—gas such as methane, nitrous oxide, ammonia, sulfur dioxide, carbon dioxide, and certain chlorinated hydrocarbons that affects the overall heat-retaining properties of the Earth's atmosphere. A build-up of these gases creates a warming of the Earth's atmosphere, thus changing the global climate.

Ground water—water stored in porous spaces of soil and rock underground. Many communities depend on ground water for their drinking water.

H

Habitat—an area where a living organism is typically located that provides adequate food, water, shelter, and living space for survival.

Hazardous waste—waste that is often produced in large quantities by businesses and industrial facilities that can be defined as ***toxic***, ***ignitable***, ***corrosive***, or ***reactive***. This type of waste is regulated by a law called the Resource Conservation and Recovery Act (RCRA) to minimize risks to human health and the environment.

Household hazardous waste—small quantities of unused or leftover hazardous products used in the home that become waste. Paints, pesticides, and some cleaners are examples of household hazardous waste. Caution must be taken when handling, storing, or disposing of these products.

Humus—the organic portion of soil; a substance resulting from the decay of plant and/or animal matter by microorganisms.

I

Ignitable—capable of burning; will catch fire at temperatures less than 140° F.

Incineration—see ***combustion/incineration***.

Incinerators—see ***combustor/incinerator***.

Integrated waste management—the complementary use of a variety of waste management practices to safely and effectively handle municipal solid waste. These practices include source reduction, recycling, composting, combustion, waste-to-energy, and landfilling.

L

Landfill—see ***sanitary landfill***.

Landfill reclamation—the process whereby old disposal cells are excavated to recover recyclable items.

Landfilling—the process of hauling waste to a landfill cell for disposal.

Leachate—occurs when precipitation seeps through a landfill and mixes with toxic and non-toxic liquids, some of which are created during biological ***decomposition***. A ***sanitary landfill*** usually has a leachate collection system where leachate is collected from the landfill and treated to prevent the ***contamination*** of ***ground water***.

Leachate collection system—a system of layers and pipes, located between the primary and secondary liners in a landfill, designed to capture all leachate and prevent groundwater contamination.

Leachate recovery facility—a special facility designed to collect liquids leaching out of a landfill to remove harmful or particulate materials.

Life cycle—the complete cycle of events occurring over the lifetime of an animate or inanimate object. For example, in the life cycle of a plant, seeds are dropped in the ground; soil, water, and ***compost*** help the plants grow; the plants drop seeds; the plants die and become compost; new seeds grow into new plants. A product life cycle is the series of steps involved in manufacturing; distributing; using; reusing, recycling, or ultimately disposing of a product.

Liner—a layer of plastic or clay placed in a ***sanitary landfill*** to prevent ***leachate*** from escaping and contaminating surrounding ***ground water***.

M

Manufacturing—the process of turning raw materials into a product or good by hand or machinery.

Methane—a colorless, odorless, flammable gas formed by the ***anaerobic decomposition*** of organic waste in a landfill. Methane also is a ***greenhouse gas*** that contributes to ***global climate change***. Many ***sanitary landfills*** have a

system in place for methane gas recovery. These facilities collect some of the methane and sell it as a source of energy for heating buildings, manufacturing products, or other uses.

Microorganisms—organisms of microscopic size, such as bacteria, amoeba, and viruses.

Municipal—properties, goods, and services owned or operated by a city or county government.

Municipal solid waste—wastes such as ***durable goods***, ***disposable goods***, containers and packaging, food scraps, ***yard trimmings***, and miscellaneous inorganic wastes from households, some commercial establishments (e.g., businesses or restaurants), institutions (e.g., schools or hospitals), and some industrial sources. It does not include nonhazardous industrial wastes, sewage, agricultural waste, hazardous waste, or construction and demolition waste. Also known as garbage, trash, refuse, or debris.

Municipal solid waste landfill—see ***sanitary landfill***.

N

Natural resources—raw materials or energy supplied by nature and its processes (e.g., water, minerals, plants). Trees are a natural resource used to make paper, and sunlight is a natural resource that can be used to heat homes.

NIMBY (Not In My Backyard)—a term indicating the attitude of individuals who oppose siting a disposal facility in their communities.

Nonrenewable resources—naturally occurring raw materials that are exhaustible and become depleted more quickly than they naturally regenerate. Some nonrenewable resources, such as peat, petroleum, and metals, are only available in limited quantities, take a long time to form, and are used up rapidly.

Nontoxic—does not contain substances that are harmful, poisonous, or destructive.

O

Oil (crude oil)—unrefined liquid ***petroleum***.

Open dumps—the outdated, unsanitary practice of discarding waste in unlined, unprepared land sites.

Organic—from a living organism (e.g., plant, animal, person, or bacteria). Also refers to a product grown or manufactured only with natural materials (e.g., corn grown with compost and not chemical fertilizer or pesticides; shampoo made from plants instead of human-made chemicals).

Organism—a living body made up of cells and tissue; examples include trees, animals, humans, and bacteria.

P

Packaging—a cover, wrapper, container, or stabilizer (e.g., strapping or pallet) designed to store, transport, display, and protect a product and/or attract purchasers.

Pathogen—an organism that causes disease, such as *e. coli* or *salmonella typhi* bacteria.

Pay-As-You-Throw (PAYT)—see ***unit-based pricing***.

Petroleum—a fossil fuel extracted from natural deposits deep in the Earth; consists of a mixture of solids, liquids, and gases that are physically separated (refined) into products such as gasoline, wax, asphalt, and petrochemical feedstocks, which are the building blocks of many plastics. Also sometimes known as ***oil (crude oil)***.

pH—a measure of acidity or alkalinity. The pH scale ranges from 0 to 14. A substance with a value less than 7 is acidic, 7 is neutral, and above 7 is alkaline.

Pollutant—a liquid, gas, dust, or solid material that causes contamination of air, water, earth, and living organisms.

Pollution—the contamination of soil, water, or the atmosphere by the discharge of harmful substances.

Pollution prevention—preventing or reducing pollution where it originates, at the source—including practices that conserve natural resources through increased efficiency in the use of raw materials, energy, water, and land. See *waste minimization*.

Postconsumer content—percentage of materials recovered by consumers (from the *municipal solid waste* stream). For example, a newspaper might be made from 30 percent recovered newsprint.

Postconsumer materials—materials recovered through recycling programs (i.e., materials recovered from the *municipal solid waste* stream, not from internal industrial processes). These materials are often used to make new products. Newspapers that are recycled by consumers, for example, are a postconsumer material used to make newsprint.

Preconsumer content—percentage of materials salvaged for reuse from the waste stream of a manufacturing process (rather than from consumers) subsequently used to manufacture a product.

Processing—see *manufacturing*.

Product—item manufactured by hand or by industry for consumers to purchase and use.

Pulp—a mixture of fibrous material such as wood, rags, and paper, ground up and moistened to be used in making paper or cardboard.

R

Raw materials—unprocessed materials used in the manufacture of products. These unprocessed materials can be either natural substances such as wood or metals or recovered materials such as crushed glass from residential recycling.

Reactive—tending to react spontaneously with air, solids, or water, explode when dropped, or emit toxic gases.

Recovered material content—see *recycled content*.

Recovered materials—materials used in a manufacturing process that are obtained from municipal recycling programs or collected from industrial processes (e.g., short paper fibers left over after making high-grade paper may be used to make paperboard).

Recovered resources—see *resource recovery*.

Recycling—collecting, sorting, processing, and converting materials that would have been thrown away into *raw materials* used to make the same or new products.

Recycling loop—the cycle of collecting and processing, manufacturing products with recycled content, and purchasing products containing recycled materials. Consumers "close the recycling loop" when they buy recycled-content items.

Recycled content—also known as recovered material content, is the percentage of material a product is made from that has been recovered from consumers in the *municipal solid waste* stream (*postconsumer content*) plus any industrial materials salvaged for reuse (*preconsumer content*).

Recyclable—material that still has useful physical or chemical properties after serving its original purpose and can be reused or remanufactured to make new products. Plastic, paper, glass, steel and aluminum cans, and used oil are examples of recyclable materials.

Residential—refers to homes and neighborhoods.

Resource Conservation and Recovery Act (RCRA)—a set of regulations that control the management of hazardous waste to protect human health and the environment.

Resource recovery—the process of obtaining materials from waste that can be used as raw materials in the manufacture of new products or converting these materials into some form of fuel or energy source. An integrated resource recovery program may include recycling, waste-to-energy, composting, and/or other components.

Resources—materials used to make products, generate heat, produce electricity, or perform work. See *natural resources*, *nonrenewable resources*, and *renewable resources*.

Renewable resource—naturally occurring raw material that comes from a limitless or cyclical source such as the sun, wind, water (hydroelec-

tricity), or trees. When properly used and managed, renewable resources are not consumed faster than they are replenished.

Reusable—material that can be used again, either for its original purpose, or for a new purpose.

Reuse—a type of ***source reduction*** activity involving the recovery or reapplication of a package, used product, or material in a manner that retains its original form or identity.

Runoff—water, usually from precipitation (rain), that flows across the ground—rather than soaking into it—and eventually enters a body of water. Sometimes carries substances, such as soil or contaminants, into a water body.

S

Sanitary landfill—a site where waste is managed to prevent or minimize health, safety, and environmental impacts. To develop a sanitary landfill, communities excavate soil and install an impermeable liner, made of plastic or clay, to prevent the contamination of ***ground water***. Waste is deposited in different cells and covered daily with soil. Sanitary landfills often have environmental monitoring systems to track performance and collect ***leachate*** and ***methane gas***. Some landfills are specially designed to handle hazardous waste.

Solid waste—see ***municipal solid waste***.

Source reduction (also known as **waste prevention**)—any change in the design, manufacture, purchase, or use of materials or products (including packaging) to reduce their amount or toxicity before they become ***municipal solid waste***. Source reduction also refers to the ***reuse*** of products or materials.

Sustainability—social and environmental practices that protect and enhance the human and natural resources needed by future generations to enjoy a quality of life equal to or greater than our own.

T

Thermophilic—"heat loving," or surviving well in high temperatures. In the composting process, heat-loving microorganisms break down food scraps and yard trimmings into a crumbly, soil-like substance.

Tipping fee—a fee assessed for waste disposal in a sanitary landfill, waste-to-energy plant, or composting facility for a given amount of waste, usually in dollars per ton. Fees are established based on disposal facility costs and the amount disposed of at the facility.

Toxic—containing compounds that pose a substantial threat to human health and/or the environment.

U

Unit-based pricing/PAYT (Pay-As-You-Throw)—a system in which residents pay for municipal solid waste management services per unit of waste (by weight or volume) collected rather than through a fixed fee. Residents, for example, might purchase a sticker to place on each bag of waste set out at the curb—the price of the sticker covers the solid waste management service costs for the volume of the bag.

V

Vermicomposting/vermiculture—a method of composting using a special kind of earthworm known as a red wiggler (*Elsenia fetida*), which eats its weight in organic matter each day. Over time, the organic material is replaced with worm castings, a rich brown matter that is an excellent natural plant food.

Virgin materials—previously unprocessed materials. A tree that is cut into lumber to make pallets is an example of a virgin material. Lumber recovered from broken pallets to make new pallets is not a virgin material but a ***recyclable*** material.

Virgin resources—raw materials that must be mined or captured from the Earth for use in the creation of products or energy.

W

Waste—see ***municipal solid waste***.

Waste management—administration of activities that provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of waste.

Waste management hierarchy—the preferred way to manage solid waste is to first practice

source reduction, then *recycle* and *compost*, and finally to combust waste at a *waste-to-energy* facility or place it in a *sanitary landfill*.

Waste minimization—includes reducing waste before it is even generated (see *source reduction*) and environmentally sound recycling. Often used in relation to hazardous waste.

Waste prevention—see *source reduction*.

Waste-to-energy—a process in which waste is brought to a facility and burned to generate steam or electricity.

Waste-to-energy facilities—specially designed waste management facilities where waste is burned to create energy, which is captured for use in generating electricity.

Waste stream—the total flow of solid waste generated from homes, businesses, and institutions that must be recycled, incinerated, or disposed of in landfills.

Windrow—large, elongated pile of *yard trimmings* or other organic materials used in the composting process, typically turned by a machine. Municipal composting programs often use windrows for large-scale composting of *yard trimmings*.

Y

Yard trimmings—grass, leaves, tree branches, brush, tree stumps, and other compostable organic materials that are generated by homes, schools, or businesses.

Glossary of Skills

Note: This resource uses the following definitions for the skills indicated in each activity.

Communication—writing or verbally expressing coherent and creative thoughts and opinions; interacting with other students to accomplish a common goal.

Computation—adding, subtracting, multiplying, dividing, or grouping numbers; recognizing and describing numerical patterns or symmetry; developing skills of estimation and judgement; using variables or equations to express relationships; developing charts, graphs, or tables to represent numerical data; giving directions or explaining ideas or concepts to others.

Motor Skills—hands-on activities such as cutting, pasting, coloring, or drawing; physical activities such as running, or, throwing and handling objects.

Observation/Classification—identifying certain physical properties or abstract qualities of objects or concepts; understanding objects or concepts according to physical or abstract similarities or differences.

Problem Solving—using prior knowledge to construct or anticipate meaning; generating and answering who, what, when, where, why questions; using data, tools, or resources to obtain information; interpreting data to explain outcomes or to predict outcomes.

Reading—reading or listening to a story, essay, dissertation, or speech; being able to comprehend, remember, and respond to questions; and following directions.

Research—using outside sources to obtain data; recording accurate data.