

HELP

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An Elementary, Interdisciplinary, Environmental Studies Activity Guidebook
about Solid Waste and Environmental Issues

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Ohio Department of Natural Resources Division of Recycling and Litter Prevention



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How to Obtain Windows on Waste

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Interested parties should contact their local recycling and litter prevention program or:

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Division of Recycling and Litter Prevention
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www.ohiodnr.com/recycling

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- Lesson VIII, pp. 21-22: Statistics adapted from the Mineral Information Institute
- Lesson XIII, pp. 16-18: *Throw-Away Societies*, adapted from *A-Way With Waste*, Washington State Department of Ecology

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ACKNOWLEDGEMENTS

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Special thanks to Jenni Worster, Tom Davis, Paul Baldrige and Arley Owens for administrative support – Ohio Department of Natural Resources, Division of Recycling and Litter Prevention

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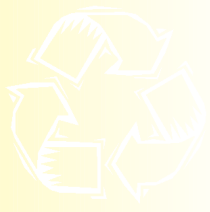
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WINDOWS ON WASTE...

Designed for Quality Education

Windows on Waste is an interdisciplinary, environmental studies resource for elementary teachers and other environmental educators. It endeavors to meet the needs of competency-based education and constructivist approaches to teaching and learning. The lessons are grounded in general environmental studies concepts as applied to solid waste management issues, with particular emphasis upon recycling and litter prevention. The lessons also address many important educational concerns in Ohio.

Ohio Competency-Based Educational Standards

The lessons that have been developed according to Ohio Competency-Based Educational Standards identified in the Model Competency-Based Education Programs for science, social studies, mathematics and language arts. This has been accomplished by developing learning activities that:

- meet instructional and performance objectives identified in the state model courses of study;
- conform with select State Proficiency Test Learning Outcomes; and
- provide assessment related to these outcomes.

Environmental Education

The lessons that have been developed in accordance with the recommendations of environmental educators. The learning activities:

- are based on learning concepts identified by the North American Association for Environmental Education;
- include attributes identified in Ohio's Strategic Plan for Environmental Education (*Ohio EE 2000*) such as problem-solving processes; critical thinking in relation to complex issues; the need to inter-relate knowledge, attitudes and skills; and the exploration of options as part of decision-making; and
- include attributes of national reform movements in education as identified by the Environmental Education Council of Ohio.

A Work in Progress

Windows on Waste is a work in progress. Achieving the standards set by the educational programs identified above is a complex and on-going concern for all environmental educators in Ohio. Local school districts are invited to use this guidebook to provide professional development opportunities for teachers. We invite all users of the lessons in this guidebook to send their comments and evaluations to the Ohio Department of Natural Resources, Division of Recycling and Litter Prevention. Evaluations of all materials may be based on standards and models identified in the bibliography.

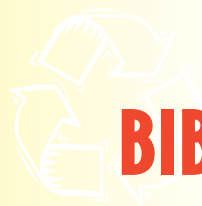
Attention: Teachers and Environmental Educators

WINDOWS ON WASTE



- ✓ **Improve** student understanding of the 4th and 6th grade Proficiency Test Learning Outcomes in:
science • citizenship • mathematics • reading and writing
- ✓ **Engage** students in real world issues about the environment by emphasizing solid waste issues, recycling and litter prevention
- ✓ **Promote** learner-centered education by using environmental inquiries and community action opportunities
- ✓ **Evaluate** student performance on 4th and 6th grade Proficiency Test Learning Outcomes using traditional and alternative forms of assessment, many of which replicate actual proficiency test questions
- ✓ **Help** make the environment a better place by promoting student involvement at:
 - home
 - school
 - neighborhoods
 - consumer markets
 - industrial plants
 - local government
 - natural resource operations
 - solid waste facilities

Windows on Waste contains a hands-on, minds-on activities, developed by the Ohio Department of Natural Resources. It can be used to explore specific subjects and learning outcomes or to create a thematic interdisciplinary issues-based approach to teaching and learning.



BIBLIOGRAPHY

The following documents provided the foundation for development of the lessons in **Windows on Waste**. Their use is recommended to evaluate the lessons for future issues.

Ohio's Model Competency-Based Programs

Model Competency-Based Language Arts Program.
Columbus, Ohio: State Board of Education, 1992.

Model Competency-Based Mathematics Program.
Columbus, Ohio: State Board of Education, 1990.

Science: Ohio's Model Competency-Based Program.
Columbus, Ohio: State Board of Education, 1994.

Social Studies: Ohio's Model Competency-Based Program.
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Assessment Related to Model Competency-Based Programs

Competency-Based Education Assessment Series ("Off-year Assessment") for Ohio's Model Competency-Based Science Program, 1998; Social Studies Program, 1997; Mathematics Program, 1997; Language Arts Program, 1995. Columbus, Ohio: State Board of Education.

Ohio Fourth-grade Proficiency Tests: A Resource Manual for Teachers of Fourth Grade and *Ohio Sixth-grade Proficiency Tests: A Resource Manual for Teachers of Sixth Grade.*
Columbus, Ohio: Ohio Department of Education, 1996.

Ohio Proficiency Tests for Grade 4: Practice Test Manual and *Ohio Proficiency Tests for Grade 6: Practice Test Manual.*
Columbus, Ohio: Ohio Department of Education, 1995.

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Environmental Studies Education

Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning. Gerald A. Leiberman and Linda L. Hoody. State Education and Environment Roundtable, 1998.

Essential Learnings in Environmental Education: A Data Base for Building Activities and Programs. North American Association for Environmental Education, 1990.

Integrating Environmental Education and Science: Using and Developing Learning Episodes. Environmental Education Council of Ohio, 1994.

Ohio EE 2000: A Strategic Plan for Environmental Education in Ohio, DRAFT. Environmental Education Council of Ohio, Ohio Alliance for the Environment, et. al., 1998.

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Ohio Revised Code: Recycling, Waste Reduction and Litter Prevention Laws. Ohio Department of Natural Resources, Division of Recycling and Litter Prevention, 1999.

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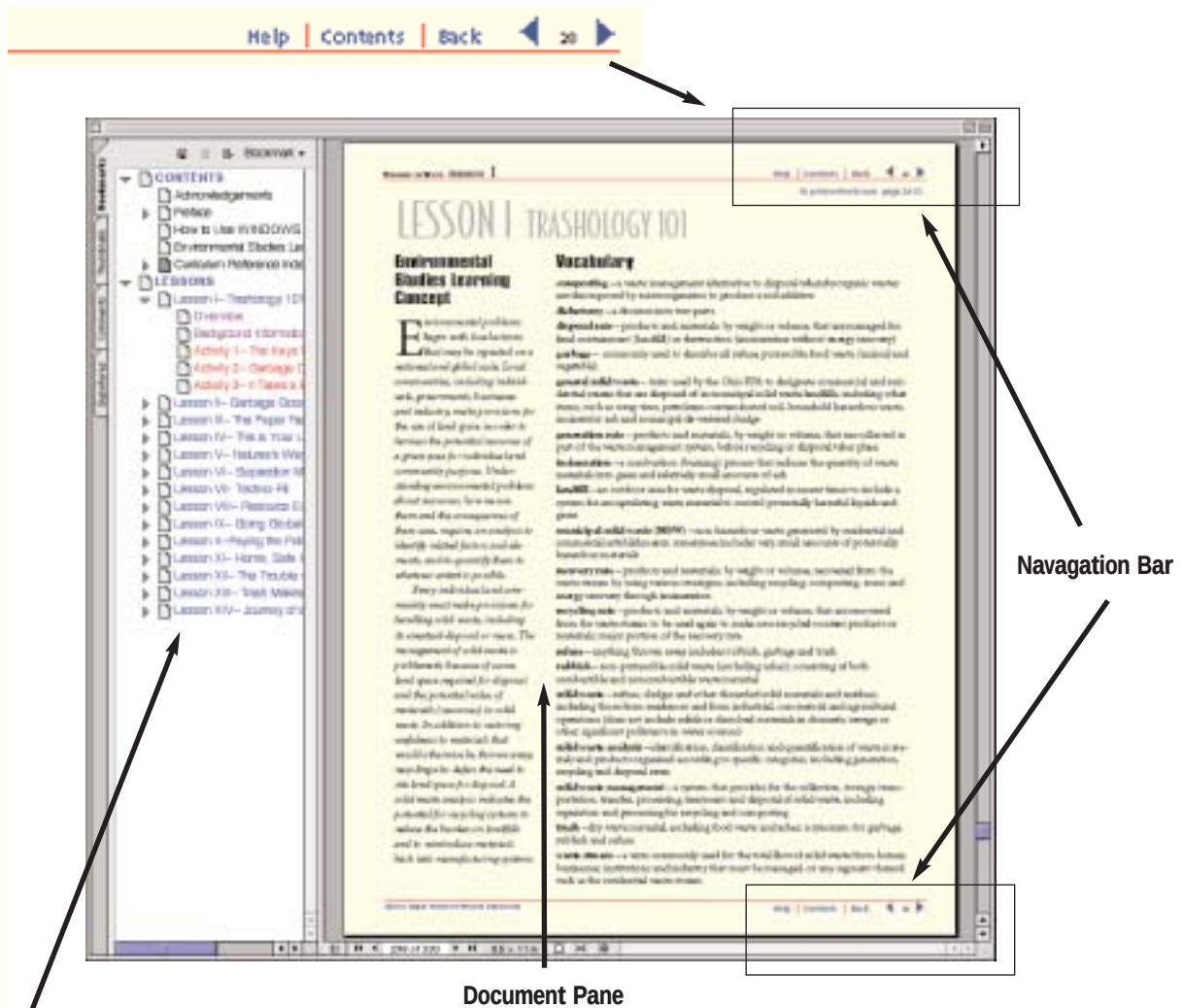
Help

Using the Navigation Bar

A navigation bar is provided at both the top and bottom of each page. Click [Help](#) to return to this guide. Click [Contents](#) to view the Table of Contents.

The navigation bar also provides the Next Page ► and the Previous Page ◀ navigation arrows before and after the page number to allow you to navigate through the pages one at a time. Click [Back](#) to view the prior screen.

All lessons, activities, and introductory sections of the text can be accessed from the Contents page. The Contents page also includes page numbers for printing select portions of the text. **When printing, be sure to select page numbers before initiating the print function, otherwise the entire text will print.**



Using Bookmarks

The contents of *Windows on Waste* are shown as bookmarks in the bookmark pane. Clicking a bookmark will take you to that part of the text. To view additional parts, click the plus sign next to a title. The title will expand to show the parts it contains. As you view the contents in the document pane, the bookmark will be highlighted in the bookmark pane to help you easily identify where you are in the document.

The bookmarks for activities also contain dropdown lists of handouts included in each activity.

How to Use WINDOWS ON WASTE

How to Identify Activities that Meet Specific Needs:

- **If you want to identify activities that meet specific Ohio Proficiency Test Learning Outcomes in science, social studies, mathematics and language arts:**
Refer to the [Curriculum Reference Index](#)
- **If you want to identify activities that relate to specific environmental studies issues:**
Refer to the [Environmental Studies Learning Concepts](#)

Read more details about each of these concepts in the Environmental Studies Learning Concept description on the first page of each lesson. The first part of the description explains general environmental studies concepts related to energy, resources, land use and/or pollution and the last part of the description explains the solid waste and recycling concepts.

- **If you want to identify activities related to home, school and/or community action, including potential field trip opportunities:**
Refer to the [School and Community Engagement Index](#)
- **If you want to identify learner centered inquiry approaches to education:**
Refer to the *Inquiries* (sidebar questions) at the beginning of each activity description in each lesson and have students conduct their own research and inquiries using the activity for background information or to investigate specific aspects of the inquiries.

How to Find Information About the Lesson

Each Lesson is self-contained with one or more activities.

Prior to the individual activity descriptions is a description of the lesson and activities included in it.

First page of each lesson

The screenshot shows the first page of a lesson titled "LESSON 1 TRASHIOLOGY 101". The page is divided into two main columns. The left column contains the "Environmental Studies Learning Concept" section, which discusses environmental problems and the role of waste management. The right column contains a "Vocabulary" section with definitions for various waste management terms. Annotations with arrows point to specific parts of the page:

- Lesson title**: Points to the title "LESSON 1 TRASHIOLOGY 101".
- Environmental concerns addressed in the activity or activities of the lesson. The first part identifies general environmental studies themes; the second part identifies solid waste management themes.**: Points to the "Environmental Studies Learning Concept" section.
- Navigation bar**: Points to the top right corner of the page.
- Identifies what pages to print when printing entire Lesson and Activities.**: Points to the "page 1 of 12" indicator in the top right corner.
- Definitions of important terms used in the lesson**: Points to the "Vocabulary" section.
- Navigation bar**: Points to the bottom right corner of the page.

Ohio Proficiency Test Learning Outcomes addressed in the activity are described (grades 4 and 6)



Background information is useful for conducting activities in the lesson



Important terms defined in the vocabulary are highlighted

How to Find Information about Each Activity

First page of each activity



Lesson title

Inquiry prompts for engaging students in the activity or in learner-centered independent discovery

Traditional subject matter of activity identified

Learning outcomes addressed by the activity are identified

List of materials required for the activity

List of handouts in the activity

Activity title

Performance objectives met by conducting the activity

Step-by-step method for conducting the activity

Answers to questions posed in steps of the activity

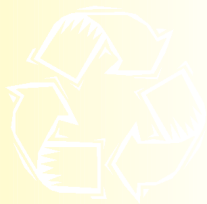
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Methods of assessing student performance objectives and proficiency test learning outcomes for the activity

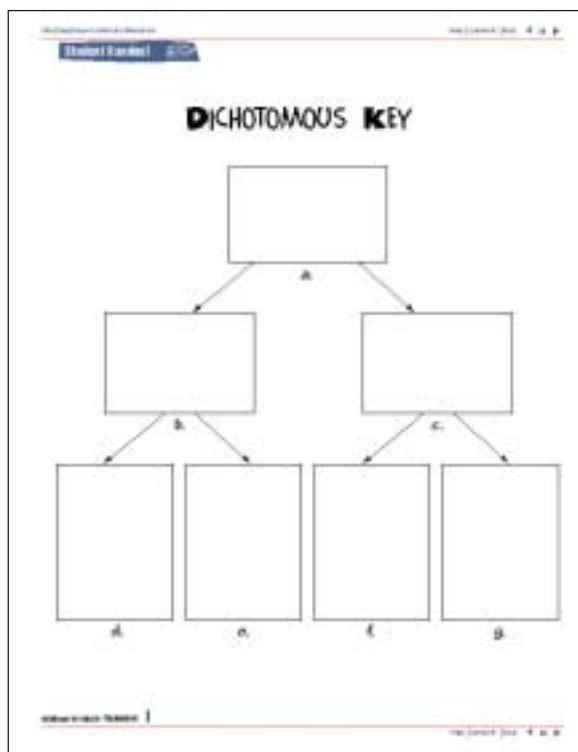
Answers to questions on handouts

Lesson title and page number using Roman numeral of the lesson and Arabic numerals inclusive throughout the entire lesson



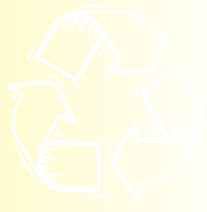
Handout pages for a specific activity are provided
at the end of that activity

Some pages are for students to actively engage in the lesson



Some pages contain information for teachers and/or students





WINDOWS ON WASTE

Environmental Studies Learning Concepts

The 14 “windows on waste,” each representing a separate lesson in this CD, are based on 14 environmental studies learning concepts. Each learning concept, or window, is composed of a general environmental studies concept (the top window-pane) and a specific environmental studies concept about solid waste and recycling (the bottom windowpane). The lesson number is identified on the window ledge of each window. Each lesson may contain one or more activities exploring the learning concept.

LAND USE AND COMMUNITY RESOURCES

Defining, quantifying and
classifying the elements of
problematic issues

SOLID WASTE ANALYSIS

Defining and quantifying
solid waste, recoverable
materials and land disposal

LESSON I

MARKET SYSTEM ECONOMICS

How businesses produce
goods and services using
natural resources

THE BUSINESS OF RECYCLING

Managing a recycling center
and the economic incentives
to use recycled materials

LESSON II

INDUSTRIAL PRODUCTION PROCESSES

How energy and resources
are used to make consumer
goods

PRODUCING WITH RECYCLED MATERIALS

Reducing the use of energy
and resources in production
processes

LESSON III

LIFECYCLE ANALYSIS

Production decisions and
environmental impacts:
energy, resources, pollution

ENVIRONMENTAL BENEFITS OF RECYCLING

Saving energy, resources
and land space, and reducing
pollution

LESSON IV

CYCLES IN NATURE

Biochemical nutrient and
energy flows in ecosystems

COMPOSTING

Solid waste reduction
process and soil quality
enhancement

LESSON V



INDUSTRIAL TECHNOLOGY

Machines and processes that make work more efficient

SOLID WASTE MANAGEMENT TECHNOLOGY

Collection, containment, compacting and sorting for recycling and disposal

LESSON VI

POLLUTION CONTROL TECHNOLOGY

Machines, materials and processes that reduce or prevent pollution

SOLID WASTE DISPOSAL TECHNOLOGY

Pollution control at landfills and incinerators

LESSON VII

NATURAL RESOURCES

Demand for and acquisition of renewable and non-renewable resources

REDUCE AND RECYCLE

Natural resource conservation and pollution reduction

LESSON VIII

INTERNATIONAL AFFAIRS

Global resource distribution, management and trade

GLOBAL SOLID WASTE MANAGEMENT

International recycling and comparative solid waste management

LESSON IX

ENVIRONMENTAL POLLUTION

Sources, pathways and effects of natural and human-made pollutants

RECYCLING AND POLLUTION

Reducing pollution in the stages of production

LESSON X

HAZARDOUS MATERIALS

Potential environmental and health risks from chemicals and materials

WASTE STREAM HAZARDS

Household hazardous materials and consumer choices

LESSON XI

IRRITATING POLLUTION

Pollutants and the senses (sights, sounds, odors, touch and taste)

LITTER

Misplaced solid waste: sources, effects, solutions

LESSON XII

HISTORY AND CULTURE

Environmental history and cultural comparisons

HISTORY OF SOLID WASTE

Past events and socio-cultural solid waste management practices

LESSON XIII

GOVERNMENT AND CITIZENSHIP

Democratic decision-making about environmental issues

SOLID WASTE ISSUES

Legislation and policy making and interest groups and citizens

LESSON XIV



CURRICULUM REFERENCE INDEX

WINDOWS ON WASTE Learning Activities and Ohio Proficiency Test Learning Outcomes, Grades 4 and 6

The lessons contained in **Windows on Waste** (WOW) provide opportunities for elementary teachers and students to address the proficiency test learning outcomes by engaging in learning activities about real world environmental issues. The lessons specifically address solid waste management, including recycling, in the context of energy, resource and land use, and pollution concerns. As with any real world issue, knowledge and skills from several subjects and disciplines are required for understanding solid waste concerns. Many lessons in WOW are interdisciplinary, addressing learning outcomes from several disciplines while others are more discipline-specific.

The outcomes in this index have been taken from two documents: *Fourth-grade Proficiency Tests: Information Guide*, Ohio Department of Education (Columbus, Ohio), August 1995 and *Sixth-grade Proficiency Tests: Information Guide*, Ohio Department of Education (Columbus, Ohio), August 1995. A more complete understanding of each of the learning outcomes may be obtained by reading the entire learning outcome description provided in these documents.

Each lesson in WOW contains one or more activities. Each activity addresses several learning outcomes and is listed below under each of the learning outcomes addressed in the activity.

The learning outcomes for science and social studies are listed here in a different order than they appear in the proficiency test guides; however, each retains the number given it in the guides. The order of presentation below represents an informal “hierarchy of importance” of learning outcomes relevant to environmental studies issues. For example, within science, those outcomes that relate directly to environmental studies concerns are listed first, followed by those that pertain to scientific thinking processes and those that pertain to subject matter (physical, life and earth sciences). Because economics and legislation are very important concerns for environmental studies, the social studies or citizenship learning outcomes have been reorganized according to subject matter in the following order: economics, civics, geography and history. The mathematics, reading and writing learning outcomes are listed in the order in which they appear in the proficiency test guides as their relevance to environmental studies is dependent upon their application to science or social issues.

For each listing in the index, the fourth grade outcomes are presented first followed by the sixth grade outcomes.

SCIENCE PROFICIENCY TEST LEARNING OUTCOMES

SCIENCE: ENVIRONMENTAL STUDIES LEARNING OUTCOMES

Grade 4, #14 Identify and/or describe the relationship between human activity and the environment.

Lesson I, Activity 1: *The Keys to Garbage*

Lesson II, Activity 1: *Econo-Community*

Lesson II, Activity 3: *Enterprising Recycling*

Lesson III, Activity 1: *Papermaking*

Lesson IV, Activity 2: *Lifecycle Hopscotch*,

Lesson V, Activity 1: *The Great Cycle*

Lesson V, Activity 2: *Bio What? That's Biodegradation!*

Lesson VII, Activity 1: *Landfill Lingo*

Lesson VII, Activity 4: *Life... Without Pollution Prevention*

Lesson VIII, Activity 1: *Show 'Em Sherlock*,

Lesson X, Activity 1: *The "Costly" Thing*

Lesson X, Activity 2: *Pollution on the Move*

Lesson XI, Activity: *Home, Safe Home*

Lesson XII, Activity 1: *Fishing for Litter Habits*

Lesson XII, Activity 2: *A Lot of Litter*

Lesson XII, Activity 3: *Don't Step on Litter*

Lesson XIII, Activity 1: *Everybody is an Expert*

Lesson XIII, Activity 2: *Secrets in a Garbage Can*

Lesson XIII, Activity 3: *Throwaway Societies*

Grade 6, #4 Identify the positive and/or negative impacts of technology on human activity.

Lesson V, Activity 1: *The Great Cycle*

Lesson VII, Activity 1: *Landfill Lingo*

Lesson VIII, Activity 2: *Mining and Recycling*

Lesson X, Activity 1: *The "Costly" Thing*

Lesson X, Activity 2: *Pollution on the Move*

Lesson XIII, Activity 1: *Everybody is an Expert*

Lesson XIII, Activity 2: *Secrets in a Garbage Can*

#17 Analyze the impacts of human activity on the ecosystems of the earth.

Lesson V, Activity 1: *The Great Cycle*

Lesson VII, Activity 3: *Finer Liner*

Lesson VII, Activity 4: *Life... Without Pollution Prevention*

Lesson VIII, Activity 1: *Show 'Em Sherlock*

Lesson VIII, Activity 2: *Mining and Recycling*

Lesson X, Activity 1: *The "Costly" Thing*

Lesson X, Activity 2: *Pollution on the Move*

SCIENCE: PROCESSES OF SCIENCE LEARNING OUTCOMES

Grade 4, #1 Create and/or use categories to organize a set of objects, organisms, or phenomena.

Lesson I, Activity 1: *The Keys to Garbage*

Lesson I, Activity 2: *Garbage Data Pie*

Lesson III, Activity 1: *Papermaking*

Lesson III, Activity 2: *What Sort of Trash is This Anyway?*

Lesson III, Activity 3: *The Paper Company*

Lesson VIII, Activity 1: *Show 'Em Sherlock*

Lesson XIII, Activity 2: *Secrets in a Garbage Can*

#2 Select instruments, make observations, and/or organize observations of an event, object, or organism.

Lesson V, Activity 5: *Compost Jars*

Lesson VI, Activity: *Separation Mania*

Lesson VII, Activity 2: *Does Your Soil Leak?*

#3 Identify and/or compare the mass, dimensions, and volume of familiar objects in standard and/or non-standard units.

Lesson V, Activity 3: *Compost Critters*

#4 Use a simple key to distinguish between objects.

Lesson I, Activity 1: *The Keys to Garbage*

Lesson III, Activity 1: *Papermaking*

Lesson III, Activity 2: *What Sort of Trash is This Anyway?*



- Lesson IV**, Activity 1: *Lifecycle Bingo*
 - Lesson V**, Activity 2: *Bio What? That's Biodegradation!*
 - Lesson V**, Activity 3: *Compost Critters*
 - Lesson V**, Activity 4: *Meet the YIMBYs*
 - Lesson VIII**, Activity 1: *Show 'Em Sherlock*

- #5 **Analyze a series of events and/or simple daily or seasonal cycles and predict the next likely occurrence in the sequence.**
 - Lesson IV**, Activity 2: *Lifecycle Hopscotch*
 - Lesson V**, Activity 1: *The Great Cycle*
 - Lesson X**, Activity 1: *The "Costly" Thing*

- #6 **Evaluate a simple procedure to carry out an exploration.**
 - Lesson III**, Activity 1: *Papermaking*
 - Lesson III**, Activity 3: *The Paper Company*
 - Lesson V**, Activity 3: *Compost Critters*
 - Lesson V**, Activity 5: *Compost Jars*
 - Lesson VI**, Activity: *Separation Mania*
 - Lesson VII**, Activity 3: *Finer Liner*
 - Lesson VII**, Activity 4: *Life... Without Pollution Prevention*

- #7 **Identify and/or discuss the selection of resources and tools used for exploring scientific phenomena.**
 - Lesson V**, Activity 3: *Compost Critters*
 - Lesson V**, Activity 5: *Compost Jars*
 - Lesson VII**, Activity 3: *Finer Liner*

- #8 **Evaluate observations and measurements made by other persons.**
 - Lesson VII**, Activity 2: *Does Your Soil Leak?*

- #9 **Demonstrate an understanding of safe use of materials and/or devices in science activities.**
 - Lesson V**, Activity 3: *Compost Critters*
 - Lesson V**, Activity 5: *Compost Jars*

- Lesson VII**, Activity 4: *Life... Without Pollution Prevention*

- #17 **Identify ways in which organisms react to changing environments.**
 - Lesson V**, Activity 3: *Compost Critters*

- #18 **Distinguish between living and non-living things and provide justification for these distinctions.**
 - Lesson V**, Activity 2: *Bio What? That's Biodegradation!*

- Grade 6, #1 **Use a simple key to classify objects, organisms, and/or phenomena.**
 - Lesson I**, Activity 1: *The Keys to Garbage*
 - Lesson V**, Activity 2: *Bio What? That's Biodegradation!*
 - Lesson V**, Activity 3: *Compost Critters*
 - Lesson V**, Activity 4: *Meet the YIMBYs*
 - Lesson VIII**, Activity 1: *Show 'Em Sherlock*

- #2 **Identify the potential hazards and/or precautions involved in scientific investigations.**
 - Lesson V**, Activity 3: *Compost Critters*
 - Lesson V**, Activity 5: *Compost Jars*
 - Lesson VII**, Activity 4: *Life... Without Pollution Prevention*

- #3 **Make inferences from observations of phenomena and/or events.**
 - Lesson V**, Activity 2: *Bio What? That's Biodegradation!*
 - Lesson V**, Activity 3: *Compost Critters*
 - Lesson V**, Activity 4: *Meet the YIMBYs*
 - Lesson V**, Activity 5: *Compost Jars*
 - Lesson VII**, Activity 2: *Does Your Soil Leak?*
 - Lesson VII**, Activity 3: *Finer Liner*
 - Lesson XIII**, Activity 2: *Secrets in a Garbage Can*



Science, continued

#5 Evaluate conclusions based on scientific data.

Lesson VII, Activity 4: *Life... Without Pollution Prevention*

SCIENCE: SUBJECT MATTER OUTCOMES (PHYSICAL, LIFE AND EARTH SCIENCES)

Grade 4, #12 Explain and/or predict the motion of objects and/or describe the effects of some objects on other objects.

Lesson VI, Activity: *Separation Mania*

#16 Demonstrate an understanding of the basic needs of living things.

Lesson V, Activity 1: *The Great Cycle*

Lesson V, Activity 4: *Meet the YIMBYs*

#18 Distinguish between living and non-living things and provide justification for these distinctions.

Lesson V, Activity 1: *The Great Cycle*

Lesson V, Activity 4: *Meet the YIMBYs*

Grade 6, #7 Predict the influence of the motion of some objects on other objects.

Lesson VI, Activity: *Separation Mania*

#12 Identify characteristics and/or patterns in rocks and soil.

Lesson V, Activity 5: *Compost Jars*

#14 Trace the transmission of energy in a small, simple ecosystem and/or identify the roles of organisms in the energy movement in an ecosystem.

Lesson V, Activity 1: *The Great Cycle*

Lesson V, Activity 3: *Compost Critters*

#15 Compare and/or contrast the diverse ways living things meet their needs.

Lesson V, Activity 3: *Compost Critters*

#16 Analyze behaviors and/or activities that positively or negatively influence human health.

Lesson XI, Activity: *Home, Safe Home*

CITIZENSHIP PROFICIENCY TEST LEARNING OUTCOMES

CITIZENSHIP: ECONOMICS LEARNING OUTCOMES

Grade 4, #10 Identify the factors of production (land, labor, capital, and entrepreneurship) needed to produce various goods and services.

Lesson II, Activity 2: *Business Boxes*

Lesson II, Activity 3: *Enterprising Recycling*

Lesson III, Activity 3: *The Paper Company: Extension*

#11 Name the resources needed to produce various goods and services, classify each resource by the factors of production, or suggest alternative uses for those factors.

Lesson II, Activity 1: *Econo-Community*

Lesson II, Activity 2: *Business Boxes*

Lesson II, Activity 3: *Enterprising Recycling*

Lesson III, Activity 3: *The Paper Company: Extension*

Lesson IV, Activity 2: *Lifecycle Hopscotch*

Lesson VIII, Activity 1: *Show 'Em Sherlock*

Lesson IX, Activity 2: *I Need This...Do You Have Some?*

Lesson X, Activity 1: *The "Costly" Thing*

#12 Classify various economic activities as examples of production or consumption.

Lesson II, Activity 1: *Econo-Community*

Grade 6, #12 Describe the role of each factor of production in producing a specific good or service and suggest alternative uses for the resources involved.

 Citizenship, continued

Lesson II, Activity 2: *Business Boxes*

Lesson II, Activity 3: *Enterprising Recycling*

Lesson III, Activity 3: *The Paper Company*:
Extension

- #13 Identify the factors that influence: (a) consumer decisions to demand goods or services, (b) producer decisions to supply goods or services.**

Lesson II, Activity 1: *Econo-Community*

Lesson II, Activity 3: *Enterprising Recycling*

- #14 Identify the factors that determine the degree of competition in a market and describe the impact of competition on a market: (a) identify advantages and disadvantages of competition in the marketplace, (b) explain the general relationship between supply, demand, and price in a competitive market.**

Lesson II, Activity 3: *Enterprising Recycling*

CITIZENSHIP: CIVIC ACTION LEARNING OUTCOMES

- Grade 4 #13 Identify the function of each branch of state government.**

Lesson XIV, Activity: *Journey of a Garbage Bill*

- #14 Identify the purposes of state government.**

Lesson XIV: *Journey of a Garbage Bill*

- #15 Identify or explain the purposes of local government.**

Lesson XII, Activity 2: *A Lot of Litter*

Lesson XIV, Activity: *Journey of a Garbage Bill*

- #16 Differentiate between statements of fact and opinion found in information about public issues and policies.**

Lesson XIV, Activity: *Journey of a Garbage Bill*

- #17 Identify and assess the possibilities of group decision making, cooperative activity and personal involvement in the community (e.g., vandalism, school rules and recycling).**

Lesson XII, Activity 2: *A Lot of Litter*

Lesson XIV, Activity: *Journey of a Garbage Bill*

- #18 Identify the elements of rules relating to fair play.**

Lesson XII, Activity 2: *A Lot of Litter*

- Grade 6, #17 Interpret how examples of political activity illustrate characteristics of American democracy.**

Lesson XIV, Activity: *Journey of a Garbage Bill*

- #19 Analyze information on civic issues by organizing key ideas with their supporting facts.**

Lesson XIV, Activity: *Journey of a Garbage Bill*

- #20 Identify and analyze alternatives through which civic goals can be achieved and select an appropriate alternative based upon a set of criteria (e.g., fire hydrant repair, use of public buildings, recycling programs).**

Lesson XIV, Activity: *Journey of a Garbage Bill*

CITIZENSHIP: GEOGRAPHY LEARNING OUTCOMES

- Grade 4, #7 Demonstrate map skills by: (a) identifying various major reference points on the Earth; (b) locating major landforms and bodies of water; or (c) using a number/letter grid system to locate places on a map, a map key to understand map symbols, a linear scale to measure distances on a map, and a direction indicator.**

Lesson IX, Activity 1: *From Ohio to the World...From the World to Ohio*

- Grade 6, #9 Interpret and analyze maps, charts or graphs to formulate geographic ideas.**

Lesson IX, Activity 1: *From Ohio to the World...From the World to Ohio*

- #15 Use information about global resource distribution to make generalizations about why nations engage in international trade.**

Lesson IX, Activity 1: *From Ohio to the World...From the World to Ohio*

Lesson IX, Activity 2: *I Need This...Do You Have Some?*

Citizenship, continued

CITIZENSHIP: HISTORY LEARNING OUTCOMES

Grade 4, #1 Demonstrate knowledge of and ability to think about the relationship among events by: (a) identifying sequence of events in history; (b) grouping events by broad historical eras on a time line; and (c) recognizing that changes occur in history; or (d) identifying cause- and-effect relationships.

Lesson XIII, Activity 1: *Everybody is an Expert*

Lesson XIII, Activity 3: *Throwaway Societies*

#2 Identify and use sources of information about a given topic in the history of Ohio and the United States.

Lesson XIII, Activity 1: *Everybody is an Expert*

Grade 6, #1 Demonstrate knowledge of and ability to think about relationships among events:

group significant individuals by broadly defined historical eras, (b) utilize multiple-tier time lines.

Lesson XIII, Activity 1: *Everybody is an Expert*

#2 Utilize a variety of resources to consider information from different perspectives about North America: (a) identify the central idea an historical narrative attempts to address, (b) inquire into the relative credibility of sources.

Lesson XIII, Activity 1: *Everybody is an Expert*

#6 Draw inferences about the experiences, problems and opportunities that cultural groups have encountered in the past.

Lesson XIII, Activity 3: *Throwaway Societies*

MATHEMATICS PROFICIENCY TEST LEARNING OUTCOMES

Grade 4, #1 Sort and identify objects on multiple attributes.

Lesson IV, Activity 1: *Lifecycle Bingo*

#3 Select appropriate notations and methods for symbolizing a problem situation, translate real life situations into conventional symbols of mathematics, and represent operations using models, conventional symbols and words.

Lesson VIII, Activity 2: *Mining and Recycling*

#4 Identify needed information to solve a problem.

Lesson II, Activity 3: *Enterprising Recycling*

Lesson III, Activity 1: *Papermaking*

Lesson III, Activity 3: *The Paper Company*

#5 Explain or illustrate why a solution is correct.

Lesson III, Activity 1: *Papermaking*

Lesson III, Activity 3: *The Paper Company*

#7 Illustrate or identify fractional parts of whole objects and like fractions greater than one, and add and subtract like fractions with illustrations and symbols.

Lesson VII, Activity 2: *Does Your Soil Leak?*

#8 Add, subtract, multiply and divide whole numbers and explain, illustrate or select thinking strategies for making computations.

Lesson I, Activity 3: *It Takes a Big Hole*

Lesson II, Activity 3: *Enterprising Recycling*

Lesson III, Activity 1: *Papermaking*

Lesson III, Activity 3: *The Paper Company*

Lesson VIII, Activity 2: *Mining and Recycling*

Lesson XII, Activity 3: *Don't Step on Litter*

#11 Add and subtract decimals.

Lesson II, Activity 3, *Enterprising Recycling*

Mathematics, continued

- #17 Apply the use of tools to measure lengths, using centimeters and inches including recognizing the positions of whole numbers and fractions on a number line.**

Lesson V, Activity 3: *Compost Critters*

- #19 Illustrate the approximate size of units of length, capacity and weight; choose an appropriate unit to measure lengths, capacities and weights in U.S. standard and metric units; and relate the number of units that measure an object to the size of the unit as well as to the size of the object.**

Lesson I, Activity 3: *It Takes a Big Hole*

- #23 Collect data and create a picture or bar graph representing the data.**

Lesson XII, Activity 1: *Fishing for Litter Habits*

- #24 Make or use a table to record and sort information (in a problem-solving setting) and make identifications, comparisons and predictions from tables, picture graphs, bar graphs and labeled picture maps.**

Lesson I, Activity 2: *Garbage Data Pie*

Lesson III, Activity 1: *Papermaking*

Lesson III, Activity 2: *What Sort of Trash is This Anyway?*

Lesson IV, Activity 2: *Lifecycle Hopscotch*

Lesson VII, Activity 4: *Life... Without Pollution Prevention*

Lesson IX, Activity 3: *Trash Around the World*

- Grade 6, #3 Apply appropriate notations and methods for symbolizing the problem statement and solution process.**

Lesson I, Activity 3: *It Takes A Big Hole*

Lesson II, Activity 3: *Enterprising Recycling*

Lesson VIII, Activity 2: *Mining and Recycling*

- #5 Validate and/or generalize solutions and problem-solving strategies.**

Lesson I, Activity 3: *It Takes A Big Hole*

- #6 Compute with whole numbers, fractions and decimals.**

Lesson I, Activity 3: *It Takes A Big Hole*

Lesson II, Activity 3: *Enterprising Recycling*

Lesson VII, Activity 2: *Does Your Soil Leak?*

- #21 Collect data, create a table, picture graph, bar graph, circle graph or line graph and use them to solve application problems.**

Lesson I, Activity 2: *Garbage Data Pie*

Lesson IV, Activity 2: *Lifecycle Hopscotch*

- #22 Read, interpret and use tables, charts, maps and graphs to identify patterns, note trends and draw conclusions.**

Lesson IX, Activity 3: *Trash Around the World*

READING AND WRITING PROFICIENCY TEST LEARNING OUTCOMES

READING: LEARNING OUTCOMES

- Grade 4, #2 Use graphic aids (for example, a table or graph) or illustrations to locate or interpret information.**

Lesson IV, Activity 2: *Lifecycle Hopscotch*

- #4 Identify and interpret vocabulary critical to the meaning of the text.**

Lesson IV, Activity 1: *Lifecycle Bingo*

- #6 Infer from the text (fiction).**

Lesson XII, Activity 2: *A Lot of Litter*

- #7 Compare and/or contrast elements such as characters, setting, or events (fiction).**

Lesson XII, Activity 2: *A Lot of Litter*

- #8 Respond to the text (fiction).**

Lesson XII, Activity 2: *A Lot of Litter*



Reading and Writing, continued

- #12 Use graphic aids (for example, a table or graph) or illustrations to locate or interpret information.**

Lesson XII, Activity 1: *Fishing for Litter Habits*

- #13 Demonstrate an understanding of text by retelling the information, in writing, in own words.**

- #14 Identify and interpret vocabulary (words, phrases or expressions) critical to understanding the text.**

Lesson V, Activity 1: *The Great Cycle*

Lesson VII, Activity 1: *Landfill Lingo*

Lesson VII, Activity 2: *Does Your Soil Leak?*

Lesson XI, Activity: *Home, Safe Home*

Lesson XII, Activity 1: *Fishing for Litter Habits*

- #17 Infer from the text.**

Lesson IV, Activity 1: *Lifecycle Bingo*

Lesson V, Activity 1: *The Great Cycle*

Lesson VII, Activity 1: *Landfill Lingo*

Lesson VII, Activity 2: *Does Your Soil Leak?*

Lesson XI, Activity: *Home, Safe Home*

- #18 Respond to the text.**

Lesson V, Activity 1: *The Great Cycle*

- #19 Choose materials related to purposes, as evidenced in part by the capacity to: (a) choose or identify reference resources to locate specific information; (b) select fiction and non-fiction materials in response to a topic or**

theme; (c) choose appropriate resources and materials to solve problems and make decisions.

Lesson IX, Activity 1: *From Ohio to the World...From the World to Ohio*

Lesson XIII, Activity 1: *Everybody is an Expert*

- Grade 6, #11 Summarize the text.**

Lesson V, Activity 1: *The Great Cycle*

- #12 Infer from the text.**

Lesson IV, Activity 1: *Lifecycle Bingo*

Lesson V, Activity 1: *The Great Cycle*

Lesson VII, Activity 1: *Landfill Lingo*

Lesson VII, Activity 2: *Does Your Soil Leak?*

Lesson XI, Activity: *Home, Safe Home*

- #13 Respond to the text.**

Lesson V, Activity 1: *The Great Cycle*

- #16 Select information from a variety of resources to support ideas, concepts, and interpretations.**

Lesson XIII, Activity 1: *Everybody Is An Expert*

WRITING: LEARNING OUTCOMES

- Grade 4, #1 Given an assigned activity direction intended to elicit modes of writing, the learner will use the writing process to make the intended clear, as evidenced by: (1) a response that stays on the topic; (2) the use of detail to support the topic and; (7) a response that shows an awareness of word usage - vocabulary, homonyms and words in context.**

Lesson V, Activity 2: *Bio What? That's Biodegradation!*

SCHOOL AND COMMUNITY ENGAGEMENT INDEX

WINDOWS ON WASTE Environmental Stewardship

Environmental studies issues, and in particular solid waste concerns, provide classroom learning opportunities related to real-life situations. The lessons in this guidebook provide opportunities for students and teachers to become active beyond the classroom through community field trip experiences and activities that benefit the environment. Field trip experiences and environmental stewardship can be integrated into classroom activities in ways that reinforce the performance and instructional objectives of the activities.

Various activities in **Windows on Waste** are indexed below according to learning and action opportunities beyond the classroom.

COMMUNITY FIELD TRIP LEARNING OPPORTUNITIES

VISIT A RECYCLING CENTER OR MUNICIPAL RECOVERY FACILITY

Lesson II, Activity 2: *Business Boxes*. How to manage a recycling facility, including business and processing decisions.

Lesson VI, Activity: *Separation Mania*. How machines are used to sort and separate materials based on their physical properties.

Lesson VIII, Activity 1: *Show'Em Sherlock*. Various aspects of recyclable products and processes.

VISIT AN INDUSTRIAL OPERATION THAT USES RECYCLED-CONTENT MATERIAL

Lesson II, Activity 3: *Enterprising Recycling*. Business incentives to use recycled-content material through energy and resource savings.

Lesson III, Activity 1: *Papermaking*. How recycled paper is used to make paper products.

Lesson III, Activity 3: *The Paper Company*. Business incentives to use recycled-content material (paper) through energy and resource savings.

Lesson IV, Activity 2: *Lifecycle Hopscotch*. Environmental reasons to use recycled materials in production processes.

Lesson X, Activity 1: *The "Costly" Thing*. How the use of recycled material (aluminum) reduces pollution.

VISIT A LANDFILL OPERATION

Lesson VII, Activity 1: *Landfill Lingo*, and **Lesson VII**, Activity 3: *Finer Liner*. How pollution control techniques are integrated into land disposal of waste.

Lesson X, Activity 2: *Pollution on the Move*. The importance of pollution prevention at landfills and other community places.

VISIT A COMPOST FACILITY

Lesson V, Activity 3: *Compost Critters*. How organic waste matter is reduced.

VISIT A MINING (OR OTHER RESOURCE ACQUISITION) OPERATION

Lesson IV, Activity 2: *Lifecycle Hopscotch*. Environmental impacts of using primary raw materials in production processes.

Lesson VIII, Activity 2: *Mining and Recycling*. Where product materials come from and the importance of recycling.

Lesson X, Activity 2: *Pollution on the Move*. The importance of pollution prevention at mining facilities and other community places.

ENVIRONMENTAL STEWARDSHIP ACTIONS AND LEARNING OPPORTUNITIES

CONDUCT A SOLID WASTE AUDIT FOR HOME, SCHOOL, OR COMMUNITY PLACES

Lesson I, Activity 2: *Garbage Data Pie*. How to identify and classify materials in the waste stream.

CONDUCT A HOUSEHOLD HAZARDOUS WASTE AUDIT AND ALTERNATIVES PROGRAM

Lesson XI: *Home, Safe Home*. How to identify and classify hazardous materials and alternatives

CONDUCT A SCHOOL RECYCLING PROGRAM OR SUPPORT LOCAL COMMUNITY RECYCLING PROGRAMS

Lesson I, Activity 2: *Garbage Data Pie*. How to identify and classify materials in the waste stream to identify potential recyclables.

Lesson III, Activity 3: *The Paper Company*. Planning a school paper recycling program.

Lesson IV, Activity 2: *Lifecycle Hopscotch*. Environmental reasons to establish a recycling program.

CONDUCT A SCHOOL COMPOSTING PROJECT TO REDUCE CAFETERIA WASTE

Lesson V, Activity 5: *Compost Jars*. Conduct a school cafeteria waste audit and plan a compost pile on the school grounds.

VISIT A GROCERY STORE OR OTHER RETAIL BUSINESS TO IDENTIFY RECYCLED-CONTENT PRODUCTS FOR CONSUMERS

Lesson II, Activity 1: *Econo-Community*. Identify recycled-content products and encourage others to purchase them.

VISIT A GROCERY STORE (OR OTHER RETAIL BUSINESS) TO IDENTIFY OVERPACKAGING FOR CONSUMERS

Lesson V, Activity 2: *Bio What? That's Biodegradation!* How to evaluate product packaging.

PLAN AND CONDUCT A LITTER PREVENTION PROGRAM AT SCHOOL OR IN THE COMMUNITY

Lesson XII: *The Trouble With Litter* (three activities). The nature of litter: Why it exists and how to prevent it.

LESSON I TRASHOLOGY 101

Environmental Studies Learning Concept

Environmental problems begin with local actions that may be repeated on a national and global scale. Local communities, including individuals, governments, businesses and industry, make provisions for the use of land space in order to harness the potential resources of a given area for individual and community purposes. Understanding environmental problems about resources, how we use them and the consequences of these uses, requires an analysis to identify related factors and elements, and to quantify them to whatever extent is possible.

Every individual and community must make provisions for handling solid waste, including its eventual disposal or reuse. The management of solid waste is problematic because of scarce land space required for disposal and the potential value of materials (resources) in solid waste. In addition to restoring usefulness to materials that would otherwise be thrown away, recycling also defers the need to site land space for disposal. A solid waste analysis indicates the potential for recycling systems to reduce the burden on landfills and to reintroduce materials back into manufacturing systems.

Vocabulary

composting – a waste management alternative to disposal whereby organic wastes are decomposed by microorganisms to produce a soil additive

dichotomy – a division into two parts

disposal rate – products and materials, by weight or volume, that are managed for final containment (landfill) or destruction (incineration without energy recovery)

garbage – commonly used to describe all refuse; putrescible food waste (animal and vegetable)

general solid waste – term used by the Ohio EPA to designate commercial and residential wastes that are disposed of in municipal solid waste landfills, including other items, such as scrap tires, petroleum contaminated soil, household hazardous waste, incinerator ash and municipal de-watered sludge

generation rate – products and materials, by weight or volume, that are collected as part of the waste management system, before recycling or disposal takes place

incineration – a combustion (burning) process that reduces the quantity of waste materials into gases and relatively small amounts of ash

landfill – an outdoor area for waste disposal, regulated in recent times to include a system for encapsulating waste material to control potentially harmful liquids and gases

municipal solid waste (MSW) – non-hazardous waste generated by residential and commercial establishments; sometimes includes very small amounts of potentially hazardous materials

recovery rate – products and materials, by weight or volume, recovered from the waste stream by using various strategies, including recycling, composting, reuse and energy recovery through incineration

recycling rate – products and materials, by weight or volume, that are recovered from the waste stream to be used again to make new recycled-content products or materials; major portion of the recovery rate

refuse – anything thrown away, includes rubbish, garbage and trash

rubbish – non-putrescible solid waste (excluding ashes), consisting of both combustible and noncombustible waste material

solid waste – refuse, sludges and other discarded solid materials and residues, including those from residences and from industrial, commercial and agricultural operations (does not include solids or dissolved materials in domestic sewage or other significant pollutants in water sources)

solid waste analysis – identification, classification and quantification of waste materials and products organized according to specific categories, including generation, recycling and disposal rates

solid waste management – a system that provides for the collection, storage, transportation, transfer, processing, treatment and disposal of solid waste, including separation and processing for recycling and composting

trash – dry waste material, excluding food waste and ashes; a synonym for garbage, rubbish and refuse

waste stream – a term commonly used for the total flow of solid waste from homes, businesses, institutions and industry that must be managed, or any segment thereof, such as the residential waste stream

Overview – TRASHOLOGY 101



Activity 1: The Keys to Garbage

Description

Students *cooperate* in groups to *make inferences* from an illustration about two basic types of garbage: natural (organic) matter and human-made materials. They *make deductions* to discuss problems that may be created when disposing solid waste. Students are given a dichotomous key to complete by *making inferences* and *deductions* about recyclable and non-recyclable materials.

Ohio Proficiency Test Learning Outcomes

Grade 4, Science #1 – Create and/or use categories to organize a set of objects, organisms or phenomena.

Grade 4, Science #4 – Use a simple key to distinguish between objects.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Science #1 – Use a simple key to classify objects, organisms and/or phenomena.

Summary

This lesson includes three activities. Each activity may be conducted separately; however, there is a logical progression from the first to the third activity. The solid waste information, such as the amounts of products and materials in the solid waste stream and recycling rates, may be used with any of the Windows on Waste lessons.

Activity 2: Garbage Data Pie

Description

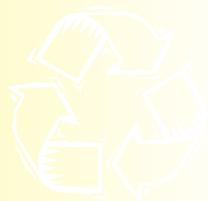
Students *cooperate* in groups to *classify* solid waste products into three categories. They make inferences to identify (on a circle graph) the relative values of products generated in solid waste. Students *interpret* another set of data about recycled materials and *deduce* what type of graph (bar chart) will best represent this data. They *construct* a bar chart and a line graph using the data presented. Students discuss the importance of a solid waste analysis that includes both product and material classifications.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #24 – Make or use a table to record and sort information (in a problem-solving setting) and make identifications, comparisons and predictions from tables, picture graphs, bar graphs and labeled picture maps.

Grade 4, Science #1 – Create and/or use categories to organize a set of objects, organisms or phenomena.

Grade 6, Mathematics #21 – Collect data, create a table, picture graph, bar graph, circle graph or line graph and use them to solve application problems.



Activity 3: It Takes a Big Hole

Description

Students *observe* how garbage materials are compacted and discuss the difference between weight and volume measurements. They *interpret* data on charts to *compare* weight and volume measurements of solid waste materials. Students follow a formula to *calculate* how much space is required to bury the garbage generated by their family, the class, the community and the state.

3

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #8 – Add, subtract, multiply and divide whole numbers and explain, illustrate or select thinking strategies for making computations.

Grade 4, Mathematics #19 – Illustrate the approximate size of units of length, capacity and weight; choose an appropriate unit to measure lengths, capacities and weights in U.S. standard and metric units; and relate the number of units that measure an object to the size of the unit as well as to the size of the object.

Grade 6, Mathematics #3 – Apply appropriate notations and methods for symbolizing the problem statement and solution process.

Grade 6, Mathematics #5 – Validate and/or generalize solutions and problem-solving strategies.

Grade 6, Mathematics #6 – Compute with whole numbers, fractions and decimals.

Background Information

What is garbage? From an informal viewpoint, **garbage** is a synonym for **refuse**, which consists of everything we throw away or place at the curb to be picked up. Formal classifications of refuse include using the word garbage to mean food waste (animal and vegetable remains) and other putrescible items, while **rubbish** refers to the non-putrescible (mostly human-made products) portion of waste materials. Rubbish is generally the portion of waste containing recyclable material. **Trash**, another common synonym for refuse, can also mean worthless, dry waste material including some organic material, such as yard waste.

From a technical perspective, the U.S. Environmental Protection Agency (U.S. EPA), uses the term **municipal solid waste (MSW)** to include various types of consumer products (durable goods, non-durable goods, containers and packaging), including food and yard waste thrown away by residences (family homes), commercial establishments (office buildings, stores, restaurants), institutions (schools, libraries, prisons), and industry (packaging and administrative wastes, not process wastes). MSW is regulated by the U.S. EPA as a class of solid waste separate from municipal sludge, agriculture and mining wastes, industrial process wastes and hazardous wastes.

General solid waste, as identified

by the Ohio Environmental Protection Agency (Ohio EPA), includes municipal solid waste and other solid waste, including contaminated soil, de-watered sludge, household hazardous waste and incinerator ash. This lesson focuses on traditional MSW, but many other types of materials and products must also be managed, and may be disposed of in community landfills.

Dealing with MSW is a local problem that can also be analyzed nationally. **Solid waste management** is the field that deals with problems associated with MSW and other types of solid waste. As with any problematic environmental situation, the first endeavor is to ask what is the problem, and how big is it? In the case

Background Information, continued

As with any problematic environmental situation, the first endeavor is to ask what is the problem, and how big is it?

of garbage, this requires a solid waste analysis.

A **solid waste analysis** illustrates the types and quantities of solid waste in a given waste stream. That information can determine how much waste must be collected and disposed, and how much can potentially be recycled. Both the U.S. EPA and the Ohio EPA conduct and publish solid waste analyses regularly; even local communities, businesses and schools can conduct their own solid waste analyses. (Refer to the Bibliography section for a listing of national and state solid waste reports.)

Three classification schemes are often used to analyze the materials and products in MSW. These are **generation rates** (how much MSW must be managed), **recovery rates** (how much MSW is recycled, composted or otherwise reused, with the majority of recovered waste being recycled) and **disposal rates** (how much MSW must be disposed of after recycling and composting). Currently, each person in the United States generates about 4.5 pounds of MSW each day, about one-third is recycled and two-thirds is disposed. The majority of disposed waste material is buried in landfills. In Ohio, 99 percent of disposed materials are sent to landfills.

Most solid waste analyses use data based on weight figures. However, volume is a more important measure from a disposal perspective because

landfills deal with lack of space issues. Volume studies are rarely carried out because measures of volume are more difficult to achieve than measures of weight.

There are other ways to classify solid waste. Those in charge of composting operations may want to know how much waste material is organic and classify these materials separately from non-compostable items; incinerator operators may want to classify waste material as combustible or non-combustible. Using a **dichotomy**, a classification scheme that divides items into two distinct classifications, is especially valuable for solid waste management. Recycling enterprises are concerned about separating recyclables from non-recyclables and then separating recyclables by type (glass, plastic, aluminum, steel, paper).

In recycling, further classification may be needed to determine specific products within a material category. For example, paper recyclers sort their products by grades and the plastics industry uses a numeric code to classify plastic products.

Over time, MSW data can also be analyzed to note increases and decreases in the amounts of certain types of materials being generated, recycled or disposed, so that manufacturers and solid waste managers can plan for future needs and identify historical trends.

Bibliography and Additional Resources

Educator Information

Characterization of Municipal Solid Waste in the United States: 1997 Update, by Franklin Associates, Ltd., prepared for U.S. Environmental Protection Agency, Report No. EPA530-R-98-007. Prairie Village, KS: Franklin Associates, Ltd., May 1998.

1997 Ohio Solid Waste Facility Data Report, by the Ohio Environmental Protection Agency, prepared in 1997 using 1996 data. Columbus, OH: Ohio Environmental Protection Agency.

1997 Summary of Solid Waste Management in Ohio: Recycling, Reduction, Incineration & Disposal, by the Ohio Environmental Protection Agency, includes data for the years 1990-1996. Columbus, OH: Ohio Environmental Protection Agency.

Waste in Place: Elementary Curriculum Guide, 6th edition, Keep America Beautiful, Inc., 1997, *Garbage Pizza*, p. 47.



TRASHOLOGY 101

Activity 1

Inquiries

- What is garbage?
- Why is garbage a problem?
- How can we classify our garbage?
- What can be done with garbage?

Content Domain

Science – General science

Social Studies – Geography

Learning Outcomes

Science, Grade 4, #1, # 4, #14
and Grade 6, #1

Duration

55 minutes

Materials

Eight trash items (four made of glass, four made of plastic) for the assessment activity: **two glass beverage bottles**, each a different color or shape; **drinking glass**; **glass cologne or perfume container**; **two plastic beverage bottles**, each a different color or shape; **plastic bread bag**; **polystyrene (plastic foam) drinking cup**

Handouts

- *Dichotomy of Solid Waste*
- *Solid Waste Dichotomous Key*
- *Dichotomous Key*

The Keys to Garbage

Objectives

Students will be able to: (a) classify solid waste according to natural and human-made items and recyclable and non-recyclable items; (b) construct a dichotomous key for solid waste management; and (c) explain what can be done with solid waste, depending upon its biological and physical attributes.

Procedure

1 Write the word “solid waste” on the board and discuss how it is another word for garbage, refuse, rubbish and trash. Explain to students that they are going to explore the characteristics of garbage, why garbage is a problem and what can be done with it. Ask students to infer why garbage is a problem. Keep their responses for later discussion.

2 The first way to explore any problem like garbage is to consider what the problem consists of, what are its elements and how these elements can be broken down into useful categories. Give students the handout, *Dichotomy of Solid Waste*, to examine two broad categories of solid waste. Define the word dichotomy (“dicho” means two and “-tomy” means to cut or divide). On the handout, clarify the specific items illustrated in each pile of waste.

Observable in Pile 1 are leaves, apple cores, banana peels, tree branches, fruit rinds and peanut shells. Observable in Pile 2 are glass and plastic beverage bottles, aluminum soda pop cans, steel cans, newspapers, cardboard boxes, refrigerator and old tires. Beneath the piles are microorganisms (bacteria and fungi), around Pile 1 are animals and

insects, and around Pile 2 are insects that may find breeding opportunities where water collects.

Divide students into groups and have them answer Question 1, with each student writing the group answer in the space provided. After a few minutes, have each group share their answer with the class.

ANSWER: (Question 1): Pile 1 contains items that are: natural, nature-made or organic; they are part of the natural environment. Pile 2 contains items that are human-made; they are part of the built environment.

3 Ask students, in their groups, to discuss and answer questions 2 and 3 on the handout. Discuss answers with the class.

ANSWERS: (questions 2 and 3): The natural materials will decay in a short period of time because animals and microorganisms will feed on and decompose the waste. Weathering elements also contribute to the destruction of organic waste material. The human-made materials, except for paper products, will not completely decay in 10 years, but will begin to break down from weathering and elements that create rust and corrosion. Plastic will begin to photodegrade from sunlight.

4 Using the completed handout, have students reflect why people do not dispose of their garbage on their own property (although some people do compost on their own property).

ANSWER: Organic waste, if it is not carefully composted, produces odors and attracts vermin, which may spread disease. Non-organic matter takes much longer to decompose, is unsightly and will collect in larger and larger piles. Items that collect water (tires in particular) may become a breeding ground for mosquitoes and other insects.

Ask students what happens to garbage when it is collected from the curb and why their answers to questions 2 and 3 might create problems for local communities attempting to dispose of everyone's solid waste.

ANSWER: Landfills are constructed and maintained to eliminate as many odor and vermin problems as possible. This is why a daily covering of soil or other material is spread over the waste. However, landfills require more and more space over time, and have the potential to pollute ground water and air. Incinerators reduce waste volume, but produce ash (sometimes toxic) that must be landfilled and have the potential to produce air pollution.

5 Ask students what alternatives exist for disposing of solid waste.

ANSWER: Nature's organic garbage can be composted, which is a type of recycling that relies on nature's recycling system. Human-made refuse and trash cannot be efficiently recycled using nature's system, and therefore, requires a human-made system that involves machines and industrial processes.

Discuss recycling and how the dichotomy of solid waste (discussed earlier) is important to know for recycling purposes.

6 Give each student the handout, *Solid Waste Dichotomous Key*, to com-

plete. The eight items listed under "All Garbage" must be broken down into two categories of four items each, then into four categories of two items each.

ANSWERS:

Can be recycled by nature's recycling system (composting): leaves, orange peels

Can be recycled in a human-made system: aluminum can, refrigerator

Can be reused as is or modified: old winter coat, shoe box

Likely to be disposed of (buried or burned): used paper plate, burned-out light bulb

NOTE: This dichotomous key is based on both social and scientific concepts. Scientific dichotomous keys are mutually exclusive, based on either/or propositions and sensory observations. Unlike dichotomous keys that are used in science, this social science dichotomous key includes categories that are not always mutually exclusive. This is because recycling and reuse are human activities that depend upon location and the types of materials accepted locally for recycling. Many recyclable items (aluminum can, old refrigerator) can also be reused and some reusable items (shoebox) can be recycled. Theoretically, almost any item in the garbage can be recycled in some type of industrial process; however, for many items it is not economically feasible. This is why the words "can be" and "likely to be" are used in the key. The assessment that follows contains a dichotomous key that is based on scientific observations about waste material, but also may relate to recycling.

7 Have students make a list of additional solid waste materials that could be included in the category: *Can be recycled in a human-made system.*

Assessment

1 Show students eight items: two

glass beverage bottles (each a different color or shape); drinking glass; glass cologne or perfume container; two plastic beverage bottles (each a different color or shape); plastic bread bag; and polystyrene (plastic foam) drinking cup. All items should be empty. Do not say anything about the items, or describe them in any way.

2 Give each student the handout, *Dichotomous Key*, and have each student work individually to complete the handout by classifying the eight displayed objects. Tell students they may come up to touch and handle each object as they please. Instruct them to fill in each blank space (letters "a" through "g") with a heading and to put the name of one or more of the eight specific items below each heading. You may wish to have them refer to the completed handout, *Solid Waste Dichotomous Key*, to serve as an example.

ANSWERS: Answers will vary depending upon organizational choices. The following are appropriate answers but others may be justifiable:

(a) "all containers" or "all items"—followed by naming each of the eight items

(b, c) "plastic containers" and "glass containers" or just "plastic and glass" (either order) — followed by naming four objects under each heading

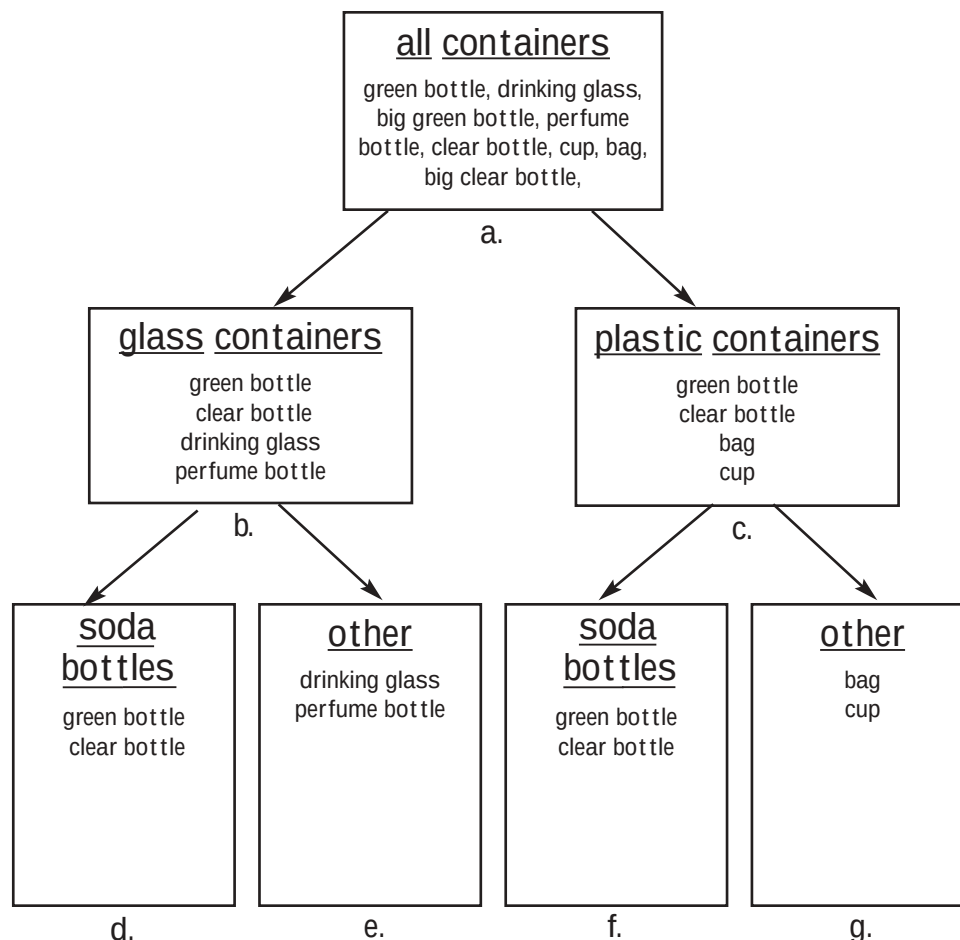
(d, e, f, g) "(glass) soda bottles," and "other" or "not (glass) soda bottles," "(plastic) soda bottles," and "other" or "not (plastic) soda bottles."

3 Refer to sample key on next page. Ask students why this dichotomy is useful for recycling purposes.

ANSWER: In order for human-made materials to be recycled, they have to be separated by material and sometimes by types of products within a specific material. For example, the beverage bottles, both glass and plastic, are frequently recycled, while the other items are more difficult to recycle.



SAMPLE DICHOTOMOUS KEY



cle. (This is because glass and plastic beverage bottles contain specific types of glass and plastic – different from other types of glass and plastic – based on specific mixtures of various raw materials.) Therefore, the heading for one of either “d” or “e” or one of either “f” or “g” could be “plastic items difficult to recycle” and “glass items difficult to recycle.”

4 Ask students if they can divide “d,” “e,” “f” and “g” further into separate categories. What would they call each category? (For example, for glass recycling purposes, it is usually necessary to separate glass beverage bottles by color: green, clear and brown. Or, in a dichotomous fashion, as “clear” and “not clear.”)

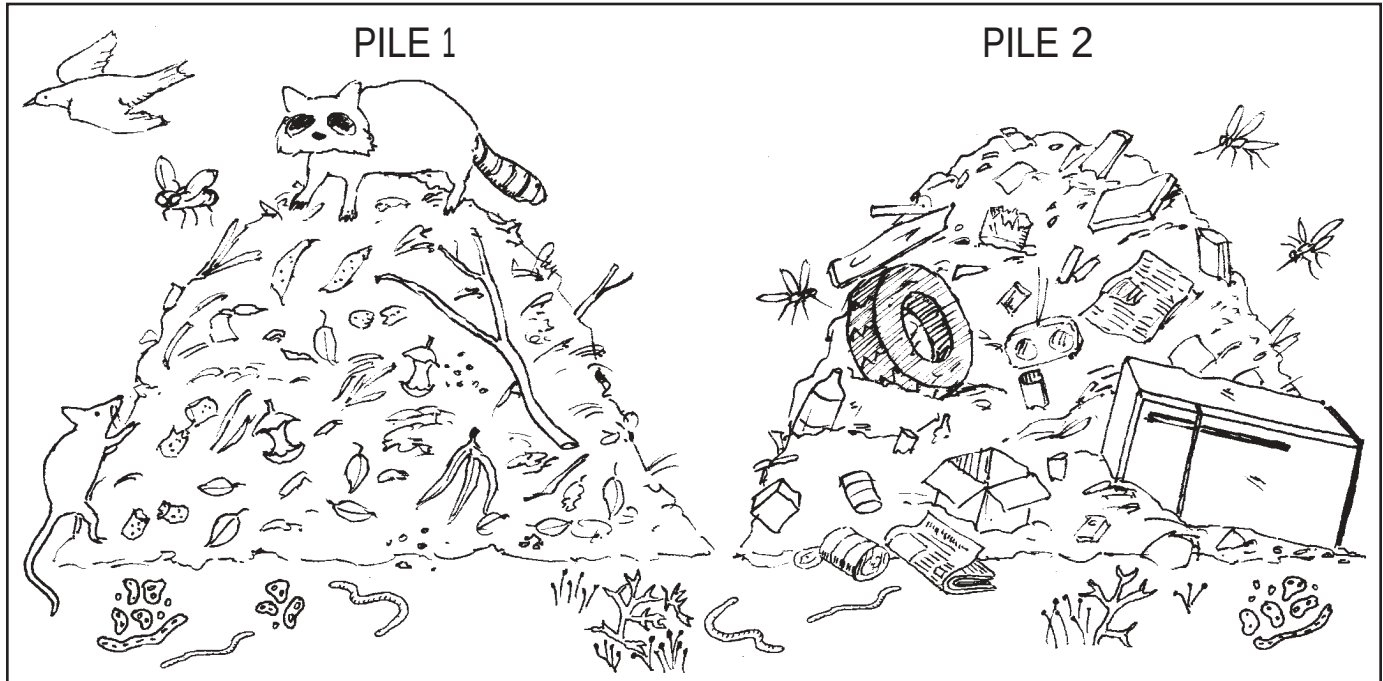
Extension

Have students construct additional dichotomous keys about waste material using the blank handout, *Dichotomous Key*. Additional dichotomies to explore include the following: organic and inorganic; combustible and non-combustible; and paper and paperboard (cardboard).

Student Handout

SOLID WASTE DICHOTOMY

There are two groups of solid waste items below that have been put into separate piles outdoors. Items that have a certain characteristic are in Pile 1. Items that have a certain characteristic are in Pile 2.



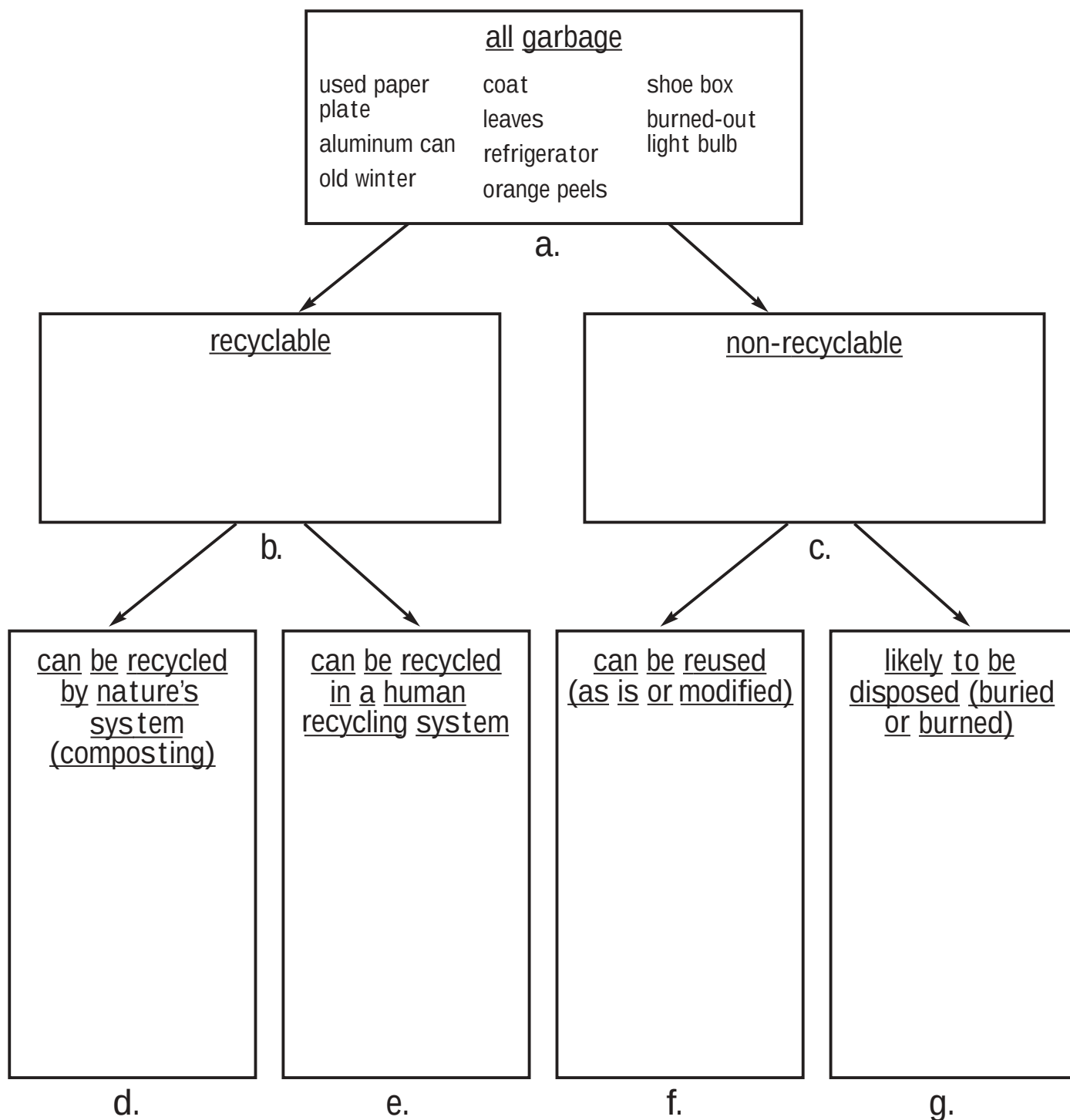
Directions: Looking at Pile 1 and Pile 2, answer the following questions.

1. What characteristic was used to separate the items into two piles. Explain your answer.
2. What will happen to the items in Pile 1 if they are left there for a period of 10 years? Explain.
3. What will happen to the items in Pile 2 if they are left there for a period of 10 years? Explain.



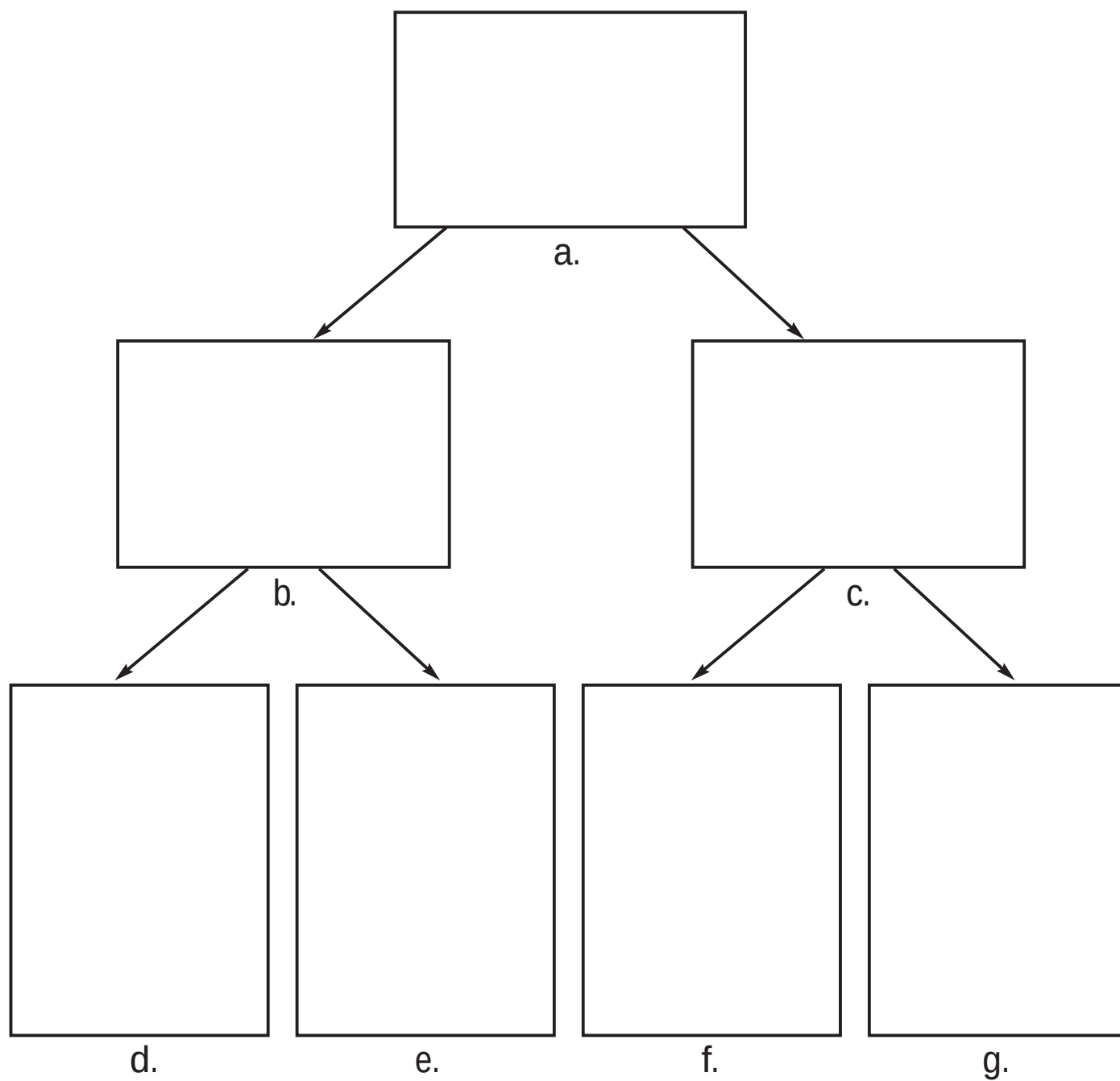
SOLID WASTE DICHOTOMOUS KEY

Directions: Place the following items into a dichotomous key.





DICHOTOMOUS KEY



TRASHOLOGY 101

Activity
2

Garbage Data Pie

Inquiries

- What is in municipal solid waste?
- How do we classify solid waste?
- How much solid waste is recycled?

Content Domain

Math – Arithmetic

Science – General science

Learning Outcomes

Math, Grade 4, #24 and Grade 6, #21

Science, Grade 4, #1

Duration

55 minutes

Materials

pencils, plain paper, optional items: **protractor, compass, graph paper**

continued next page

Objectives

Students will be able to: (a) cooperate in groups to construct a solid waste analysis; (b) interpret solid waste data and identify relative values on circle graphs and/or create their own circle graphs to represent the data; (c) interpret solid waste data and represent the data in a variety of graphic forms; and (d) explain the importance of classifying solid waste according to specific products and materials for recycling.

Procedure

1 Define and explain the terms *municipal solid waste (MSW)* and *solid waste analysis*. Explain to the class that a research group conducts a national solid waste analysis of items in the municipal solid waste stream and gives this information to the U.S. Environmental Protection Agency (U.S. EPA). Explain the role of the U.S. EPA as the federal government agency responsible for protecting the environment. Tell the class they will be examining data from the U.S. EPA's municipal solid waste report.

2 Give each student the handout, *Goods Galore & Garbage*. In groups, have students complete the handout. Discuss the three categories listed at the top of the handout, and then have groups begin listing items (products or goods) under the various categories. Have students complete the top half of the handout, listing items thrown away at home. After discussing these items, have them think of items thrown away at school, placing them into the three categories. The handout, *Waste Stream*

Products, which contains numerous examples for each of the three categories, can be used for teacher or student reference.

3 Tell students they will be examining the U.S. EPA solid waste analysis based on the categories of the completed handout, *Goods Galore & Garbage*. But before doing so, ask students what types of garbage were not included in the handout, *Goods Galore & Garbage* (food waste and yard waste). Remind students that the separation of food and yard waste from products is based on a dichotomy between natural and human-made materials (done in Activity 1).

4 Give each student the handout, *Products in Municipal Solid Waste*, and review the information. Discuss the relative nature of the categories and give them the circle graph handout, *Graphing Data: Products in MSW*. Have students fill in the spaces on the pie chart (label the circle bases) with the appropriate product category. Or, if capable, have students make circle graphs for the data using a compass and



protractor. (You may also have them write in the circle bases the names of some specific products identified on the handout, *Goods Galore & Garbage*.) Make sure students understand that in a circle graph all circle bases or sections must total 100 percent.

You can modify this step by copying the handout, *Products in Municipal Solid Waste*, with the percentages covered so they are blank, and have students make calculations to derive percentages rounded off to the nearest figure.

5 Ask students if there is another way, using a different type of graph, they can represent the data from the handout, *Products in Municipal Solid Waste*. (The actual amounts by weight or the percentages can be represented in a bar graph.) Give students the blank handout, *Bar Graph*, to complete by labeling it appropriately and filling in the first five columns with weight data.

NOTE: Students need to fill in headings “a” (PRODUCTS, there will be five to list) and “b” (MILLIONS OF TONS PER YEAR) and give the chart a title (PRODUCTS IN MSW). Students also need to decide how many million tons each square should represent (10 million up to 100 million), putting numbers in the spaces provided below heading “b.”

Upon completing steps 4 and 5, the students now have two representations of different sets of data about the same products in MSW. These represent a solid waste analysis.

6 Ask students to reconsider the products in the categories and how the products differ, other than the categories: durable goods, non-durable goods, containers and packaging. In other words: What is another way to organize a solid waste analysis?

ANSWER: The products can be organized according to the materials they

are made from. Categorizing by material is especially important for recycling, because only products made of the same material can be recycled together. Although glass bottles, aluminum cans and plastic containers may all be collected together, they must be recycled in separate processes. Refer to the handout, *Materials in Municipal Solid Waste*, also used in the Assessment section. You may want to make an overhead of this handout to introduce students to the materials that products are made from.

7 In pairs, give each student the handout, *Materials Recycled*. Discuss the information. Ask which type of graph can be used to represent this data.

ANSWER: A bar graph, because the percentages given are for each material, not the total of all materials. (The total of all materials percentages would be more than 100 percent.) *Exception:* A circle graph could be constructed for each material to compare the amount recycled with the amount not recycled (or amount disposed of). This would require many graphs, one for each material.

Give each student another copy of the blank handout, *Bar Graph*, to complete by labeling it appropriately and filling in all 12 columns.

NOTE: Students need to fill in headings “a” (MATERIALS, there will be 12 to list) and “b” (PERCENTAGE OF MATERIAL RECYCLED) and give the chart a title (MSW MATERIALS RECYCLED). Students also need to decide how many percentage points each square should represent (10 percent up to 100 percent), by putting the numbers in the spaces provided below heading “b.”

8 *Optional:* Ask students what other type of information does the data on the top half of the handout, *Materials Recycled*, reveal, in addition to materials recycled?

TRASHOLOGY 101

Handouts

- *Goods Galore & Garbage*
- *Waste Stream Products*
- *Products in Municipal Solid Waste*
- *Graphing Data: Products in MSW*
- *Bar Graph*
- *Materials Recycled*
- *Materials in Municipal Solid Waste*
- *Graphing Data: Materials in MSW*
- *What Do the Data Say?*

ANSWER: The MSW disposal rate for each material. This can be derived by subtracting each percentage from 100 percent. This subtracted figure would represent the percentage of each material that is disposed of after recycling or composting. Have students construct a comparative bar graph for recycling and disposal rates using this data.

9 The data at the bottom half of the handout, *Materials Recycled*, provides information about recycling rates from 1960 to 1995. Discuss with students how this information can be graphed. (A line graph is most appropriate.) Have students construct a line graph using this data.

Assessment

1 Give students the handouts, *Bar Graph*, *Materials in Municipal Solid Waste* and *Graphing Data: Materials in MSW*. Have them label the circle graph and the bar graph for the two sets (columns) of data deciding which set of data to use for each graph.

2 Have students complete the test handout, *What Do the Data Say?*

ANSWERS: 1. c, 2. b, 3. c, 4.- 6. Refer to the handout, *Materials in Municipal Solid Waste*, 7. c, 8. Answers will vary.

Extensions

1 Have students in groups discuss various methods of conducting a school solid waste analysis or waste audit. Have each group present their ideas and as a class choose the best

group method. Initiate the solid waste audit and have each group construct various methods of representing the data that has been collected and make classroom presentations.

2 Conduct the activity, *Garbage Pizza*, from Keep America Beautiful, which is referenced in the Bibliography section of the lesson.

3 Explain to students that the data they have shows that in any community products are thrown away in the relative quantities presented on the circle graphs, but in some communities the values may differ slightly. However, the more samples you have, the more likely it is that the overall data will reflect national figures. To show how sampling works and what probability means, do the following activity:

- Divide students into pairs and give each pair a set of “spinner” materials (Make a spinner with a pencil and paper clip. Poke the pencil in the center of the circle graph through a bent, extended paper clip with a point that can be flicked around the pencil lead with a finger).
- Have each pair make a list of each of the product or material categories from one of the circle graphs to use as a tally sheet.
- Have one student place their spinner on the circle graph and spin it while the other records which product or material category is selected by the spinner. Have each pair do this 25 times, trading places half way through the spins.
- When each pair has completed 25 spins, have them compare their data

with the national figures and then record data from all pairs of students and compare with the national data. The entire class should be more representative of national data than the individual pairs.

Student Handout

GOODS GALORE & GARBAGE

DURABLE GOODS

Products that last a long time before they are thrown away or recycled (washing machine, hair dryer, television).

NON-DURABLE GOODS

Products that last a short period of time before they are thrown away or recycled (paper plates, junk mail, some toys).

CONTAINERS and PACKAGING

Products that preserve food and hold other things that generally last a short period of time before they are thrown away or recycled (aluminum can, plastic grocery bag).

GENERATED AT HOME

DURABLE

NON-DURABLE

CONTAINERS and PACKAGING

GENERATED AT SCHOOL

DURABLE

NON-DURABLE

CONTAINERS and PACKAGING

WASTE STREAM PRODUCTS

Consumerism is reflected in the products found in our solid waste stream. These can be classified as durables, non-durables, containers and packaging, and other wastes including food waste and yard trimmings.

Durable products may have a lifetime of three years or more (up to 20 years) before being discarded. Non-durable products last for less than three years and include many one-time use items. Containers and packaging items have varying life spans, but are generally short-lived.

The following list is representative of the major product categories for each classification.

DURABLES

Major Appliances

refrigerators*
washing machines*
water heaters*

Small Appliances

toasters
hair dryers

coffee pots Furniture

couches/chairs
lamps
tables
beds

Carpets/Rug

Lead-Acid Batteries*

Vehicle Tires

Miscellaneous

televisions
video cassette
recorders
personal computers
luggage
sports equipment

NON-DURABLES

Paper Products

books/magazines
paper*
(copier/computer)
newspaper*
mail
napkins/tissues
plates/cups/bowls
games

Plastic Products

plastic tableware
food service containers

Disposable Diapers

Textiles

clothing/footwear*
bedding

Miscellaneous

household items
medical supplies
novelty items
toys

CONTAINERS & PACKAGING

Aluminum

beverage cans*
foil
closures (tabs)

Glass

beverage bottles*
food jars*
cosmetic packaging

Paper/Paperboard

boxes*
food/beverage
containers
retail bags/boxes
wrapping paper

Steel

beverage cans*
food cans*
strapping

Plastic Containers/ Packaging

bottles (PET- #1
& HDPE-#2)*
bags (LDPE, LLDPE)*
coatings & closures
other- (made from a
variety of resins -PVC,
PS, PP)

Other Packaging

wood packaging*
(crates/pallets)
textiles
leathers

OTHER WASTES

Food Waste

Yard Trimmings

Miscellaneous inorganic waste

*Indicates items that are commonly recycled depending upon location. Non-asterisked items may be more difficult to recycle or establish recycling programs for.

PRODUCTS IN MUNICIPAL SOLID WASTE (MSW)*

GENERATION RATE PRIOR TO DISPOSAL OR RECYCLING

Percentages indicate the percentage of each product category in relation to the total amount of all products generated in MSW.

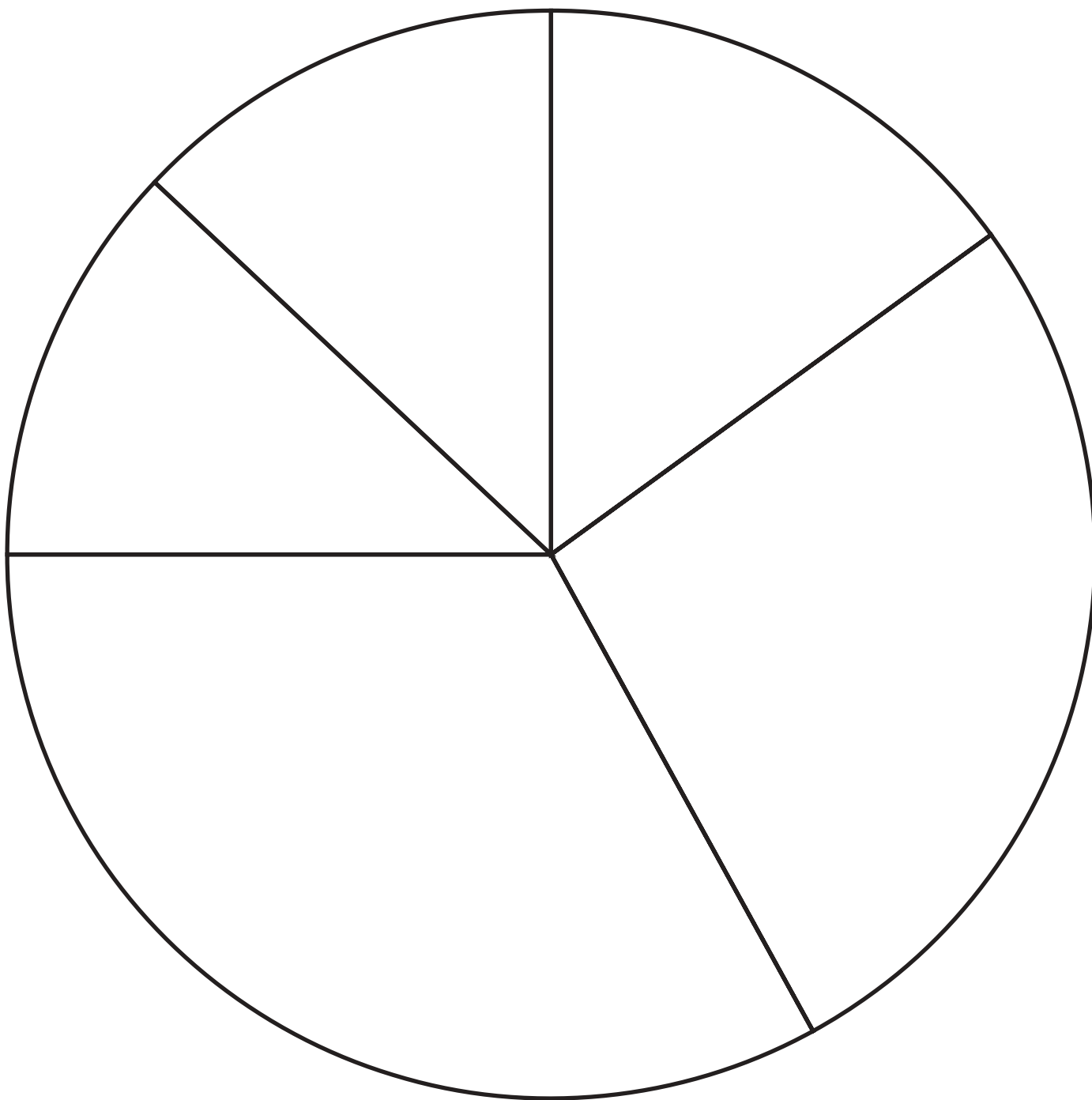
PRODUCTS	MILLION TONS PER YEAR	PERCENTAGE
Durable goods	31	15%
Non-durable goods	56	27%
Containers & packaging	69	33%
Food, other	25	12%
Yard trimmings.....	28	13%
TOTAL	209	100%

*Franklin Associates, Ltd., Characterization of Municipal Solid Waste in the United States: 1997 Update (published by the U.S. Environmental Protection Agency, May 1998, using 1996 figures), p. 6. Figures include wastes from residential, commercial and institutional sources. Does not include automobile scrap, construction and demolition debris and industrial process wastes.



GRAPHING DATA: PRODUCTS IN MSW

CIRCLE GRAPH

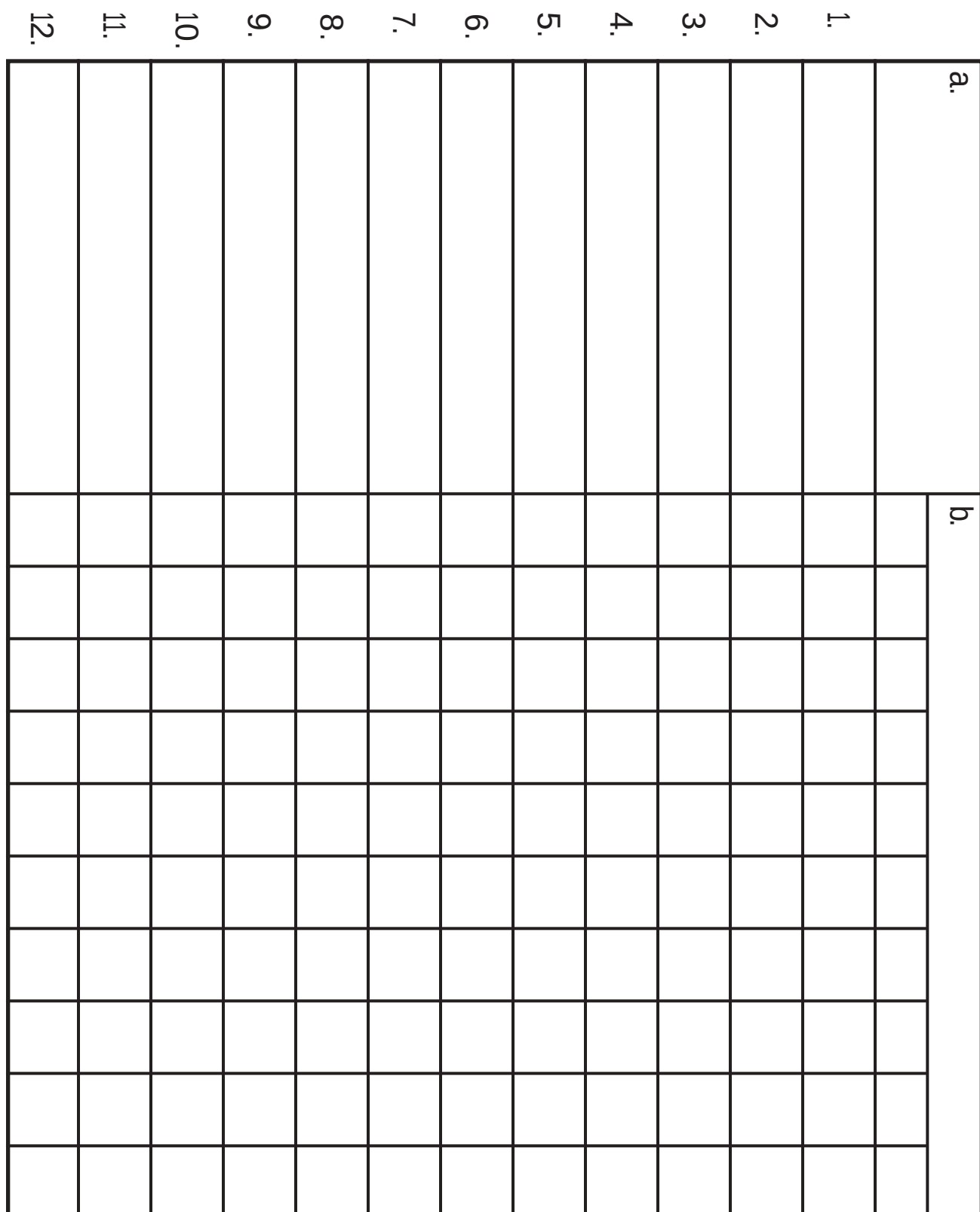


Student Handout



BAR GRAPH

Title:



MATERIALS RECYCLED*

AND MATERIALS COMPOSTED

Figures indicate the percentage of each material recycled or composted in relation to the total amount of the particular material. (Example: 40% of all paper and paperboard products were recycled; 60% were not recycled.)

MATERIALS IN PRODUCTS

Paper & paperboard	41%	Plastics	5%
Glass	26%	Rubber & leather	10%
Ferrous metals	38%	Textiles.....	12%
Aluminum	34%	Wood	5%
Other nonferrous metals.....	67%	Other materials.....	21%

OTHER WASTE

Food, other	2%	Yard trimmings.....	39%

TOTAL RECYCLING RATE IN 1996 FOR ALL MATERIALS IN MUNICIPAL SOLID WASTE: 27%

HISTORICAL RECYCLING RATES (FOR ALL MATERIALS): 1960-1990

1960	6%
1970	7%
1980.....	10%
1990	16%

*Franklin Associates, Ltd., Characterization of Municipal Solid Waste in the United States: 1997 Update (published by the U.S. Environmental Protection Agency, May 1998, using 1996 figures), pp. 5, 27, 52. Figures include wastes from residential, commercial and institutional sources. Does not include automobile scrap, construction and demolition debris and industrial process wastes.

MATERIALS IN MUNICIPAL SOLID WASTE

GENERATION RATE PRIOR TO DISPOSAL OR RECYCLING

Each of the materials below is found in products in the waste stream. Percentages indicate the percentage of each material in relation to the total amount of all materials generated in MSW.

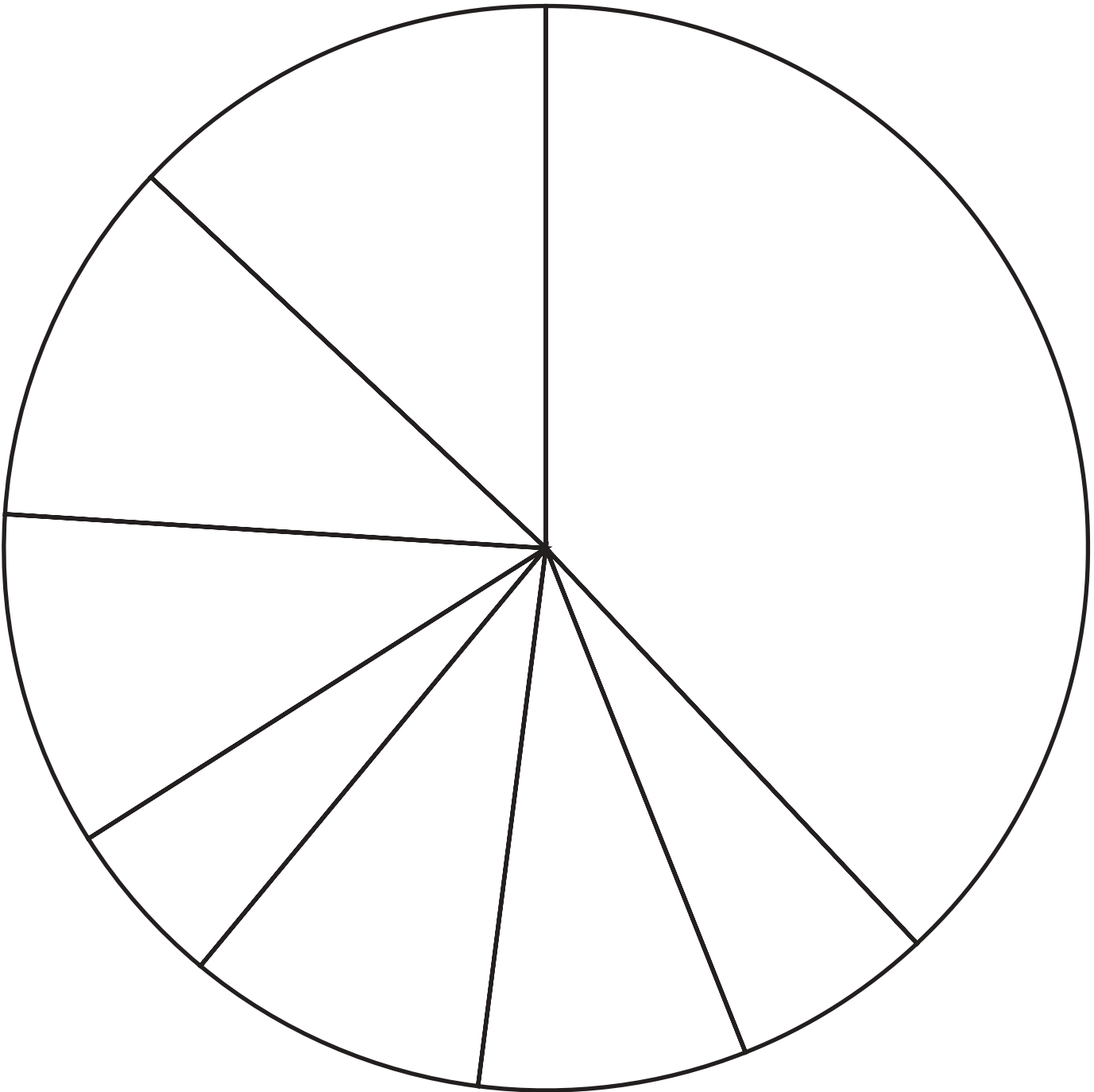
MATERIALS	MILLION TONS PER YEAR	PERCENTAGE
Paper & paperboard	80	38%
Glass	12	6%
Metals	16	8%
(Ferrous	12)	
(Aluminum	3)	
(Other nonferrous	1)	
Plastics	19	9%
Wood	11	5%
Other materials	21	10%
(rubber, leather, textiles, miscellaneous inorganic)		
Food	22	11%
Yard trimmings	28	13%
TOTAL	209	100%

*Franklin Associates, Ltd., Characterization of Municipal Solid Waste in the United States: 1997 Update (published by the U.S. Environmental Protection Agency, May 1998, using 1996 figures), pp. 4, 51. Figures include wastes from residential, commercial and institutional sources. Does not include automobile scrap, construction and demolition debris and industrial process wastes.



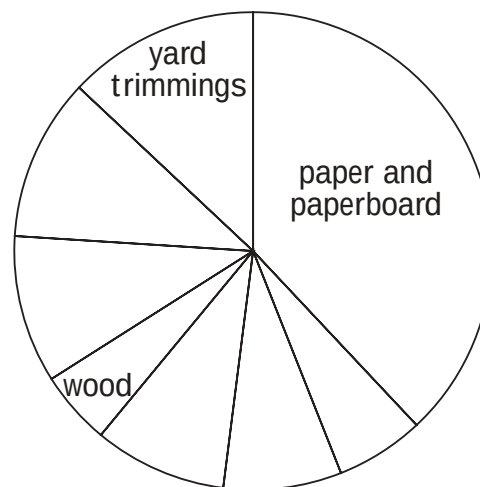
GRAPHING DATA: MATERIALS IN MSW

CIRCLE GRAPH



WHAT DO THE DATA SAY?

Directions: Answer the questions below by placing the correct letter or answer in the blank(s) provided.



Three types of solid waste materials are identified in the circle graph to the right.

- _____ 1 Which material represents 38% of all solid waste materials generated?
a. yard trimmings b. wood c. paper and paperboard
- _____ 2 Which material represents 5% of all solid waste materials generated?
a. yard trimmings b. wood c. paper and paperboard
- _____ 3 The total of the percentages of all eight types of solid waste materials (all eight sections of the circle graph) is:
a. 180% b. 45% c. 100% d. 90%

Name three types of materials (not listed on the circle graph above), which are also materials found in municipal solid waste.

4 _____ 5 _____ 6 _____

- _____ 7 People put old or used products in their garbage. It is important for recycling purposes to know what type of materials these products are made of because:
a. some materials make better or more useful products than others
b. some recyclable materials last longer than others
c. materials must be recycled separately from each other
d. products of different materials can be recycled together
- _____ 8 In Ohio in 1996, 32% of all solid waste was recycled. The rest was disposed of in landfills or incinerators. On the back of this page, make a circle graph. Label and give percentages for both the recycling rate and the disposal rate. Also, give your graph a title.

TRASHOLOGY 101

Activity
3

It Takes a Big Hole

Inquiry

- What amount of land space is required to dispose of solid waste?

Content Domain

Math – Arithmetic

Learning Outcomes

Math, Grade 4, #8, #19 and Grade 6, #3, #5, #6

Duration

45 minutes

Materials

pencil, paper

Handouts

- *Weight in Space*
- *Making Reservations at the Landfill*

Objectives

Students will be able to: (a) explain the difference between measurements of weight and volume as they apply to solid waste disposal; and (b) calculate the volume of space required to bury waste at a landfill.

Procedure

- 1 Discuss with students the difference between measurements of weight and volume.
- 2 Give students the handout, *Weight in Space*, and compare the figures for the materials based on weight and volume (space). Ask students: Why do some materials take up more space than weight relative to other materials? Conduct a demonstration, or have students experiment to densify various items of trash, such as a plastic cup and a paper cup that are the same size.
- 3 Discuss how, when conducting a solid waste analysis, it is more difficult to arrive at “exact” measurements of volume than for weight for solid waste materials. Have students mentally picture a garbage truck arriving at a landfill. The truck could be weighed (on a scale) or the landfill operator might calculate the amount by the volume of garbage in the truck. (Estimates of volume are less reliable than those based on weight because there is less consensus of what constitutes volume mea-

surements, particularly under landfill conditions where compaction varies from landfill to landfill and truck to truck.) The handout, *Weight in Space*, shows volume measures for waste material based on one method derived from a garbology project at the University of Arizona. The next step includes a handout with another method of deriving volume.

Most solid waste analyses are conducted with measurements of weight, as indicated in the previous activity; however, the problem for communities is often one of space at the local landfill.

- 4 Have students complete the handout, *Making Reservations at the Landfill*. Review and discuss answers. Before answering the last question on the handout, you will need to give students some idea of the size of a cubic yard.
- 5 In groups, have students brainstorm problem-solving strategies for calculating one of the following:
 - (a) How much garbage does the community generate in a year and how much space would it require at a land-

fill? (You will need to use population data of your local community and, if this data is not broken out into adults and children, figure an average for both – 4.5 pounds per day.)

(b) How much garbage is generated in the state of Ohio on a yearly basis? (The population of Ohio is approximately 11 million people.)

6 Have groups create pictures of how much space each of these amounts of garbage would require.

7 Discuss with students how recycling can reduce our dependence on landfill space. Pose the following problem: If 25 percent of all solid waste generated is recycled, how much less landfill space would be required in each of the cases above? Calculate what this would be if the recycling rate is 30 percent, 40 percent, 50 percent. (Many experts believe that a recycling rate above 50 percent is unrealistic.)

Assessment

Whichever problem was used in Step 5, choose the other one to give each student to assess their understanding.

WEIGHT IN SPACE*

Below are two charts that indicate the type of materials discarded in landfills and incinerators in the United States. These materials are from consumer products that people buy, use and throw away. All of these things are called municipal solid waste or MSW. The majority (99%) of MSW discarded in Ohio is disposed of in landfills.

MATERIALS AND PRODUCTS DISCARDED IN MSW BY WEIGHT*

(As a percentage of the total amount of materials discarded, after materials recovery)

PAPER & PAPERBOARD	32%
YARD WASTE.....	14%
PLASTICS	12%
OTHER WASTES	12%
FOOD WASTES	9%
WOOD	9%
METALS.....	6%
GLASS	6%
TOTAL.....	100%

MATERIALS DISCARDED IN MSW BY VOLUME*

(As a percentage of the total amount of materials discarded, after materials recovery)

PAPER & PAPERBOARD.....	34%
PLASTICS.....	20%
OTHER WASTES	15%
METALS.....	12%
YARD WASTE.....	10%
WOOD	4%
FOOD WASTES	3%
GLASS	2%
TOTAL.....	100%

*These figures are based on a solid waste analysis conducted in 1990 using 1988 data. Source: Franklin Associates, Ltd., Characterization of Municipal Solid Waste in the United States: 1990 Update prepared for the U. S. Environmental Protection Agency (Prairie Village, KS: 1990), pp. 87-88.

Student Handout

MAKING RESERVATIONS AT THE LANDFILL

Most adults create about 5 pounds of garbage each day and most children (under 12) create about 4 pounds each day. Complete the calculations below to determine how much space you will need at the landfill for your family's trash for one year.

A. DETERMINE THE NUMBER OF POUNDS OF GARBAGE YOUR FAMILY GENERATES IN ONE YEAR

- 1 Number of adults in your family _____ x 5 lbs. = _____ lbs. per day/adults
- 2 Number of children in your family _____ x 4 lbs. = _____ lbs. per day/children
- 3 Adult lbs. _____ + children lbs. = _____ family lbs. per day
- 4 Family lbs. per day _____ x 365 days a year = _____ family lbs. per year

B. CALCULATE HOW MUCH SPACE WILL BE REQUIRED AT THE LANDFILL FOR A YEAR'S WORTH OF YOUR FAMILY'S TRASH (Each 1,000 lbs. of material requires one cubic yard of space at the landfill.)

- 5 Family lbs. per year _____ divided by 1,000 = _____ cubic yards per year

C. AS A CLASS, CALCULATE HOW MUCH SPACE WILL BE REQUIRED AT THE LANDFILL FOR A YEAR'S WORTH OF GARBAGE FROM ALL OF THE FAMILIES IN YOUR CLASS. Show your work below.

- 6 On the back of this page, draw a picture to show how big of a space it would take to bury the trash figured in Part C above. How would you compare the size of the space with a car, a dump truck, a house, a school, other? Show this building or other item in relationship to the size of the pile of garbage.

GARBAGE GOODS

Environmental Studies Learning Concept

Economic activities require the use of natural resources and therefore impact the environment. Business and industry utilize resources to produce economic wealth. They rely on inputs in the form of resources and energy to provide goods and services. Sometimes, the desire to produce wealth conflicts with the conservation of natural resources.

Solid waste results from the economic decisions of consumers and producers. It is composed of materials and products that were discarded, but at one time represented the wants and needs of consumers. Recycling renews usefulness to materials that would otherwise be wasted by reintroducing them back into production processes. This can provide economic incentives to recycle by reducing the costs of production. When economics alone does not provide an incentive to recycle, environmental concerns provide reasons to recycle, including saving energy, resources and land space (for landfills), and reducing pollution. Recycling also promotes an ethical value – frugality.

Vocabulary

capital – the resources, used to produce a good or service, made by past human efforts including buildings, machinery, vehicles and tools; a factor of production

entrepreneurship – the ability of a person to make decisions about using economic resources to make a profit

factors of production – all of the resources required to produce a good or service divided into four groups of productive resources: land, labor, capital and entrepreneurship

goods – things or tangible products that are produced by manufacturers

labor – the knowledge, skills and physical abilities of people used to produce a good or service; a factor of production

land – the natural resources, or materials used in place of natural resources, that are used in production processes; a factor of production

market – a gathering of people for buying and selling things; a type of economic organization in which the forces of supply and demand are relied upon to make decisions about the production and consumption of goods and services

natural resources – raw materials occurring in nature

primary materials – natural resources used in production processes

raw materials – natural resources, processed materials or recycled materials used in manufacturing processes

recycling – the act of collecting and separating materials and products from the solid waste stream and reusing them as raw materials in manufacturing processes

secondary materials – the recycled materials used as raw materials in production processes

services – actions that are provided by public and private enterprises

Overview – GARBAGE GOODS

Activity 1: Econo-Community

Description

Students are introduced to basic economic concepts such as goods, services, consumption and production in relation to natural resources, solid waste management and recycling. Students *develop group discussion skills* by responding to inquiries about the “wants” associated with five recyclable products that represent common recyclable materials in the municipal solid waste stream. They place “missing pieces” (representing businesses) on an economic model by *interpreting information* and *making inferences* from sequential stages in the production of the five products. Students *analyze* the model closely to *make deductions* about the environmental benefits of recycling and what is necessary to “close the production-consumption loop.”

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #11– Name the resources needed to produce various goods and services, classify each resource by the factors of production, or suggest alternative uses for those factors.

Grade 4, Citizenship #12– Classify various economic activities as examples of production or consumption.

Grade 4, Science #14– Identify and/or describe the relationship between human activity and the environment.

Grade 6, Citizenship #13– Identify the factors that influence: consumer decisions to demand goods or services, producer decisions to supply goods or services.

Activity 2: Business Boxes

Description

Students role-play entrepreneurs of a recycling business, *manipulating materials* to construct models of their businesses using shoe boxes. They *cooperate in groups* to *problem solve* what is needed to operate a recycling business. Students *read and interpret* the definitions of the factors of production and *classify* the elements of a recycling business according to each factor.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #10 – Identify the factors of production (land, labor, capital and entrepreneurship) needed to produce various goods and services.

Grade 4, Citizenship #11 – Name the resources needed to produce various goods and services, classify each resource by the factors of production, or suggest alternative uses for those factors.

Grade 6, Citizenship #12 – Describe the role of each factor of production in producing a specific good or service and suggest alternative uses for the resources involved.



Summary

This lesson includes three activities. Although each may be conducted separately, the first activity provides a good foundation for conducting the second and third activities, especially for students with a limited understanding of economic concepts. The third activity is an extended version of the second activity and requires more time and materials.

Activity 3: Enterprising Recycling

Description

Students *analyze* the role of natural resources and recyclable materials as factors of production. They role-play entrepreneurs who produce recycled-content products. Students *conduct research* about the production of specific products and *manipulate materials* to build model factories using shoe boxes and make illustrations based on their research. Students *compare* the costs of producing products from natural resources and from recycled materials by *reading and interpreting* economic information to *solve mathematical problems*.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #10 – Identify the factors of production (land, labor, capital and entrepreneurship) needed to produce various goods and services.

Grade 4, Citizenship #11 – Name the resources needed to produce various goods and services, classify each resource by the factors of production, or suggest alternative uses for those factors.

Grade 4, Mathematics #4 – Identify needed information to solve a problem.

Grade 4, Mathematics #8 – Add, subtract, multiply and divide whole numbers and explain, illustrate or select thinking strategies for making computations.

Grade 4, Mathematics #11 – Add and subtract decimals.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Citizenship #12 – Describe the role of each factor of production in producing a specific good or service and suggest alternative uses for the resources involved.

Grade 6, Citizenship #13 – Identify the factors that influence: consumer decisions to demand goods or services, producer decisions to supply goods or services.

Grade 6, Mathematics #3 – Apply appropriate notations and methods for symbolizing the problem statement and solution process.

Grade 6, Mathematics #6 – Compute with whole numbers, fractions, decimals.

Background Information

Recycling, generally perceived as an environmental action, is also an integral part of our economic system. It plays a role in our economic market system because it involves the production of both goods and services. Environmentally, recycling offers a beneficial alternative to waste disposal. In general, it conserves energy, resources and land space. Therefore, the incentives to recycle include both economic and environmental factors.

Two types of **markets** are important to recycling. First, and most observable, is the *market for consumer goods*, in which goods such as food, containers and appliances are purchased by individuals and households. Most of these goods, at one time or another, end up as solid waste. If they are taken to a landfill for disposal they are wasted, whereas recycling offers a chance to reuse these goods.

Most citizens are familiar with recycling collection programs, but collection is only half of the story. As recyclable materials become part of manufacturing processes, they enter another type of market, the market for resources. In the *market for resources*, manufacturing businesses are consumers of resources – both natural and recycled – for the production of goods.

It is often said that economic decisions begin with a “want” – a consumer demand for a good or service within the market system. In other words, individuals and households must “want” (buy) recycled-content products to provide an incentive to recycle. Producers will then meet this consumer demand. On the production side, there is another incentive to use recycled material, when producers

can lower production costs (save money) by using recycled materials in place of natural resources.

Using recycled materials benefits the economy and the environment. From an economic perspective, as production costs are lowered, profits may increase and consumer prices are likely to decrease. From an environmental perspective, resources, energy and land space may be conserved depending upon the industrial processes used to make specific goods. Recycling, however, is problematic because collecting and processing recycled materials is not always economically sustainable, and using recycled materials in manufacturing does not always guarantee lower production costs.

Producers make economic decisions based on the **factors of production**. The factors of production are land, labor, capital and entrepreneurship. Examples within each factor are called productive resources, or resources. **Land** refers to productive

resources or processed materials, the latter being natural resources that have been refined by manufacturing processes. For example, iron ore is a “natural” raw material in the production of steel, while steel is a “processed” raw material in the production of automobiles. Recycled materials are processed raw materials that may take the place of primary raw materials in manufacturing processes.

Capital, another factor of production, includes resources such as tools, machines and buildings. One way to identify whether a productive resource is land or capital, is to remember *land resources become part of the good or product being produced*. *Capital resources, on the other hand, do not become a part of the good being produced*. This is another reason why recycled material and energy are considered land resources.

Labor is a factor of production that consists of the knowledge, skills and physical abilities of the people

Recycling, generally perceived as an environmental action, is also an integral part of our economic system.

resources occurring in nature (trees, minerals, soil, water, plants and animals). Land resources are also **natural resources**. Recycled materials are land resources because they can be used in place of natural resources. Energy and energy sources are also land resources.

Natural resources and recycled materials are used as raw materials to make products. Natural resources are called **primary (raw) materials** or virgin materials, while recycled materials are called **secondary (raw) materials**. Primary materials may be nat-

that are used to produce goods and services. Sometimes labor is called a human resource or human capital (the latter denoting developed skills).

Entrepreneurship is the ability to make decisions about how to use the other factors of production so a product makes a profit. Entrepreneurs are people who start businesses with initial investments.

The factors of production are used to produce a good or provide a service within the context of markets and communities. Overall land use

Background Information, continued

within a community is based on the types of goods and services that are produced and sold. Communities themselves include three important sectors of the economy: services sector, manufacturing sector and natural resources sector.

Services are actions. The services sector includes private businesses and public enterprises such as schools, grocery stores, retail stores, local government, and health care and medical providers. Solid waste collection is a service provided by a local government, private waste haulers or a combination of both. **Goods** are things, or tangible products that are produced in the manufacturing sector. **Natural resources** are those things that exist in nature (not made by humans) that can either be used to make products or enjoyed as they exist in nature. Recyclers collect and prepare used goods so that they can be used in manufacturing processes instead of natural resources. For this reason, recycling enterprises may be considered as part of the natural resources sector of the economy.

Bibliography and Additional Resources**Student Resources**

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GARBAGE GOODS

Activity
1

Econo-Community

Objectives

Students will be able to: (a) identify production and consumption activities that are part of our economic system; (b) explain how the production of goods, including those made from recycled materials, is based on consumer demand to satisfy wants or needs; (c) explain how recyclables are used after they have been diverted from solid waste disposal; and (d) identify the natural resources used to make common goods and explain how using recyclables can reduce the amount of natural resources and energy used in production processes.

Procedure

1 You may pre-assess student understanding of the economic concepts that will be part of the activity by using one or both of the methods explained in the Assessment section of this activity. Use the pre-test to determine which terms and concepts are not clearly understood so you can emphasize them during the activity. Or, if students show an understanding of concepts and terms in the activity, you may wish to advance to one of the next two activities in the lesson.

2 Arrange the five display items (plastic detergent bottle, writing paper tablet (lined), aluminum soda can, glass pickle jar and steel soup can) so all the students can see them. Lead a discussion about basic economic concepts by following inquiries on the teacher handout, *Teacher-Led Inquiry of Economic Terms*.

3 After the inquiry discussion, give each student the handout, *Econo-Puzzle*.

Discuss the meaning of the handout as a model of our economic system. Initially, tell students to disregard the numbered blank spaces. They represent businesses that the students will soon examine. Explain how the terms “services,” “goods,” and “natural resources” indicate important sectors of the economy in which businesses exist. Ask students to give other examples of goods, services and natural resources other than the ones depicted in the model.

4 Have students make inferences about what type of businesses the numbered blank spaces may represent. Do this by giving each student the half-page handout, *Missing Pieces*, and have them cut out the various businesses and place them on the model where they think they belong. After reviewing each answer, have students glue the businesses in the appropriate spaces.

ANSWERS: 1. plastic bottle factory, 2. paper factory, 3. glass jar factory, 4. aluminum can factory, 5. steel can factory,

Inquiries

- What happens to recycled materials after they have been collected?
- How is recycling a part of the economic system?
- What are the environmental benefits of recycling?

Content Domain

Science – Natural resources

Social Studies – Economics

Learning Outcomes

Citizenship, Grade 4, #11, #12 and Grade 6, #13

Science, Grade 4, #14

Duration

50-75 minutes

Materials

Five items for display: **plastic detergent bottle, writing paper tablet (lined), aluminum soda can, glass pickle jar, steel soup can** (containers should be unopened); **scissors and glue** (for each student); **transparency of the handout, Econo-Community** (optional)

Handouts

- *Teacher-Led Inquiry of Economic Terms*
- *Econo-Puzzle*
- *Missing Pieces*
- *Econo-Community*
- *How Five Goods are Produced*
- *Econo-Community Model: Follow-up Questions*
- *Goods, Garbage & Resources*

6. recycling facility, 7. garbage collection facility, 8. landfill

The handout, *Econo-Community*, depicts all the answers. You may wish to make an overhead of this for use in the discussion which follows.

5 Review with students the sequence of businesses that are required in order to produce each of the five display products. The supplemental handout, *How Five Goods are Produced*, may be used by the teacher or given to students to help explain the various production processes. Some natural resources required to make the food products are not depicted on the model, such as plants and animals (farming). You may wish to ask students which resources and businesses are missing and have them write the name of the business on the model in the appropriate sector. The handout, *How Five Goods are Produced*, provides information on businesses that are missing.

NOTE: The entire model is generic in nature. With any product item, the number of businesses involved in the production of the various goods or natural resources will vary at different stages. Also, many more ingredients, chemicals and processes are required than are depicted.

6 Have students identify the natural resources used to make common goods and alternative uses of these resources by examining the *Econo-Community* model and answering the following questions:

- Which natural resource is required to make each of the various products (containers, writing paper, etc.) in the model?
- What other types of products can be made from glass, plastic, paper, steel and aluminum, other than the ones depicted in the model?
- What is the value of recycling in the

model? You may wish to use the handout for teacher-led discussion, *Econo-Community Model: Follow-up Questions*, for this purpose.

7 Have students look at the *Econo-Community* model and describe what is meant by the phrase “closing the loop.” The “production-consumption” loop is closed when materials are recycled and consumers then buy those recycled materials. Have students trace a loop on the model for any one material. They can begin with a product (can, bottle, paper, etc.) in their household garbage, trace its path through garbage collection and separation for recycling, its reintroduction into the manufacturing process, its sale to stores where it is bought by consumers. The production-consumption loop is not completed when recyclable materials are thrown away because their use ends at the landfill.

8 Have students examine the loops they made. Ask what natural resources are saved when recycled materials are used. (Both natural resources and energy resources are saved.) A recycled-content product is rarely made using 100 percent recycled material. Some amount (varying from 10 to 90 percent) of natural resources is typically required when using recycled material, depending upon the product produced.

Assessment

Assess student understanding of the terms and concepts in the activity by using one or both of the following methods.

Method A: Assemble the five display items (plastic detergent bottle, writing paper tablet (lined), aluminum soda can, glass pickle jar, steel soup can) so all students can see them. Have each student choose one of the items and depict its history in the form of a diagram with pictures and written

descriptions to explain the diagram and pictures. Students should depict everything – natural resources, businesses, consumers, etc. – associated with the “life of the product.” They should also include what happens to the product when it is and when it is not recycled. Use a rubric to evaluate the projects.

Method B: Have students complete the handout, *Goods, Garbage & Resources*. This latter assessment uses language and concepts of the state model proficiency test outcomes.

ANSWERS to handout, *Goods, Garbage & Resources*: 1. b, 2. c, 3. b, 4. a, 5. b, 6. d

Extensions

1 Have students research the manufacturing of the products in the activity to discover the complexities (other businesses and resources) that are not represented in the model.

2 Revisit the economic concept of consumer demand based on “wants.” If people want to conserve resources and energy and save landfill space, they must buy recycled-content products. Take students or have them visit, on their own, a local store and ask them to make a list of products made from recycled-content materials. Ask the store to display posters or other materials (brochures, etc.) created by the students that tell consumers what types of recycled-content products are sold in the store.

Teacher-Led Inquiry of Economic Terms

Before classroom discussion:

Set up the five display items below so all students can view them:

- plastic detergent bottle
- writing paper tablet (lined)
- glass pickle jar
- aluminum soda can
- steel soup can

1 How do the five items represent what (some) people want?

What are the “wants” associated with the detergent bottle?

The person or consumer “wants” clothes to be clean, “wants” what is in the detergent, “wants” a sturdy, unbreakable container, “wants” a strong handle for carrying, etc.

What are the “wants” associated with the writing paper tablet?

The consumer “wants” paper to write something on, “wants” lined paper to write in straight lines, “wants” the quantity of sheets supplied, “wants” the stiff backing for support, etc.

2 What do all five items have in common?

Among various answers, be sure to point out that all five are considered goods, in economic language. Goods are tangible things (things you can see, touch, smell, taste or hear).

3 Why do people buy goods at a store, such as a grocery store? Why not buy each item individually from the business that makes it? It may even be cheaper to buy each item directly from the business that produces it.

People, or consumers, “want” a service. A grocery store provides the service of distributing a variety of items at one location so people do not need to go to various locations. So when people buy goods at a store, they are also buying a service.

4 How is a service different from a good?

A service is an action, not a thing or product.

5 What are examples of businesses that provide services? (*banks, hospitals, gas stations, etc.*)

What are examples of businesses that produce goods?

Any type of manufacturing enterprise or factory for cars, soap, toys, etc.

6 What are natural resources?

They are things that occur in nature, such as minerals (coal, iron ore, copper, gem stones), water, plants and animals.

7 What is consumption?

Solicit examples of someone consuming (buying) a good and a service. (Parents consume education – a service – for their children.)

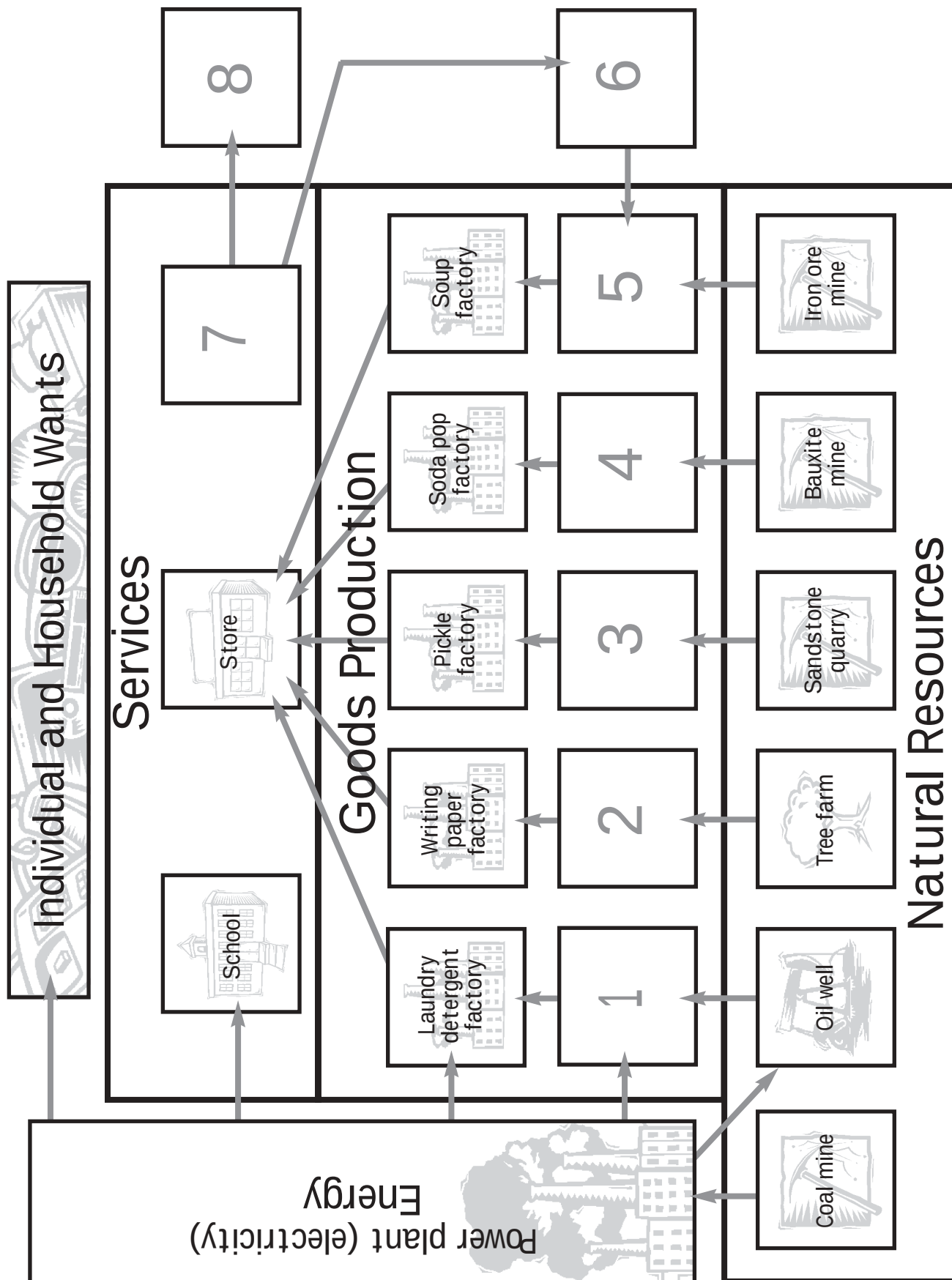
8 What is production?

Solicit examples of someone producing (making) a good and a service. (Teachers are examples of people producing a service – education.)

Student Handout

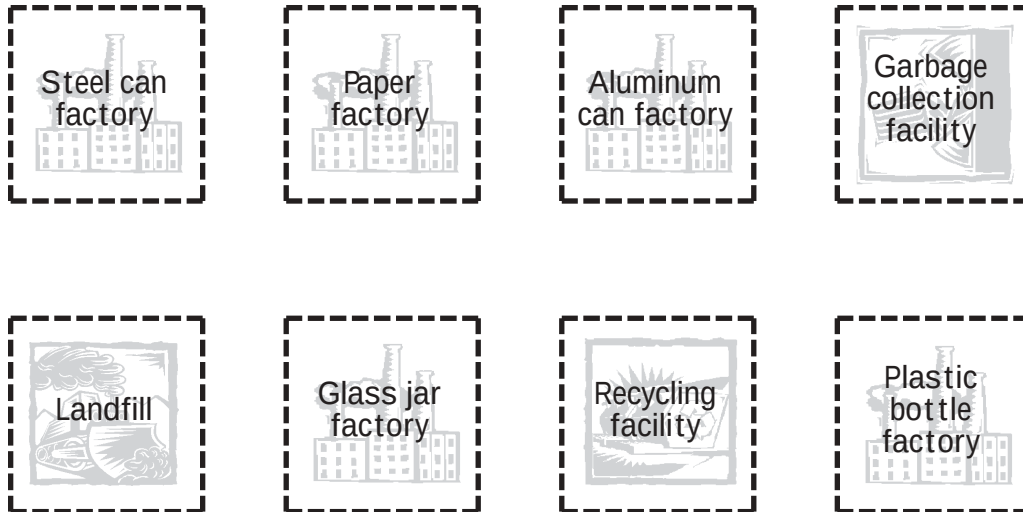


ECONO-PUZZLE

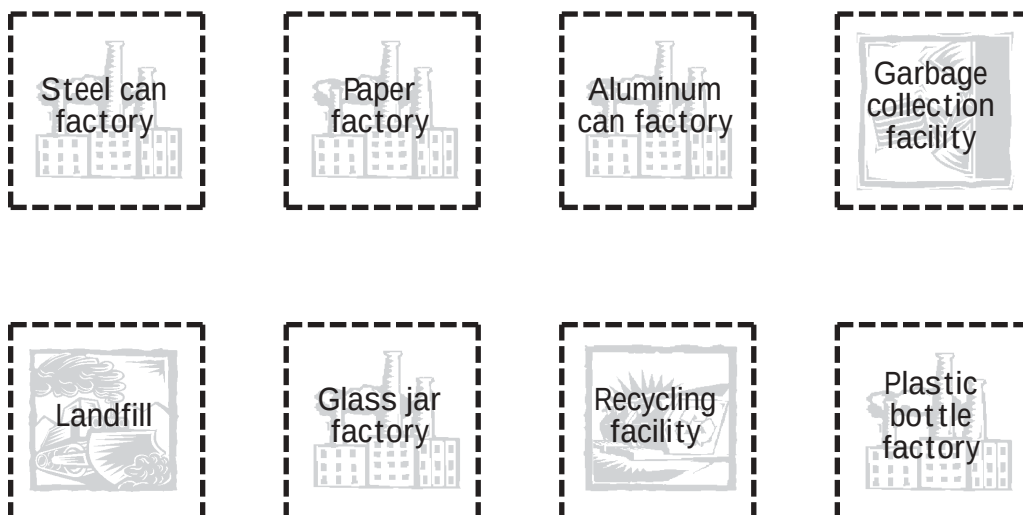


Student Handout

MISSING PIECES

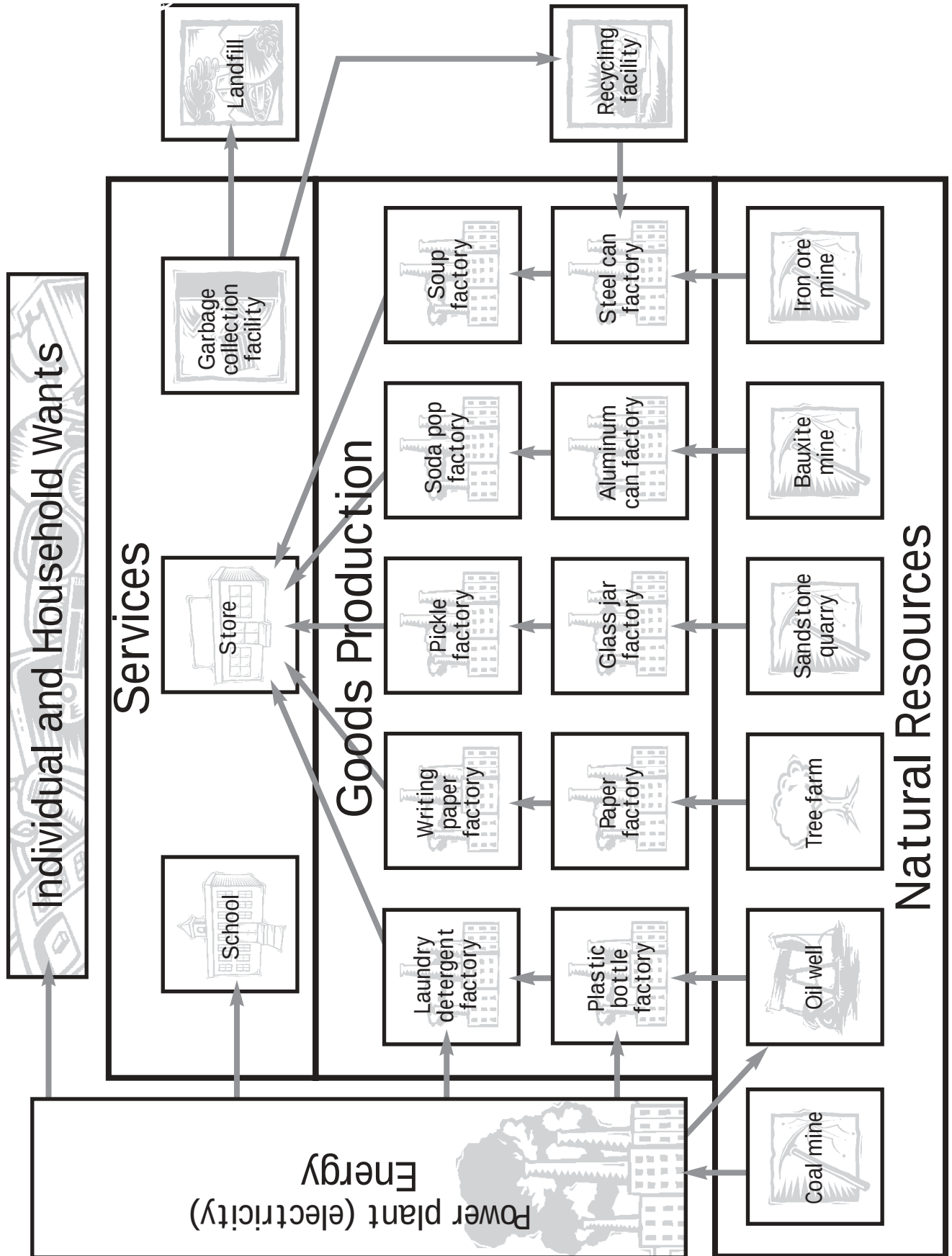


MISSING PIECES



Econo-Puzzle Key

ECONO-COMMUNITY



HOW FIVE GOODS ARE PRODUCED

LAUNDRY DETERGENT PRODUCTION

Two goods are involved – the detergent and the plastic container.

In the **natural resources sector**, an *oil well business** must extract petroleum and make plastic resin from it. [A business must extract the petroleum needed to make the detergent.]**

In the **goods production sector**, a *plastic bottle factory* must use plastic resin to make plastic bottles in which to put the detergent. It sells the containers to a *laundry detergent factory*, which makes detergent from natural resources and puts it in the bottles.

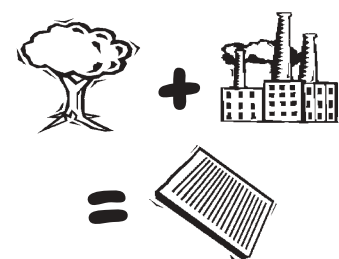


WRITING PAPER TABLET PRODUCTION

Although no packaging is implied in this model, sometimes tablets come wrapped in plastic.

In the **natural resources sector**, a *tree farm business* must cut down trees and grind them into chips.

In the **goods production sector**, a *paper factory* uses wood chips to make rolls of paper. A *writing paper factory* buys the rolls of paper and cuts them into sheets and prints lines on the sheets.

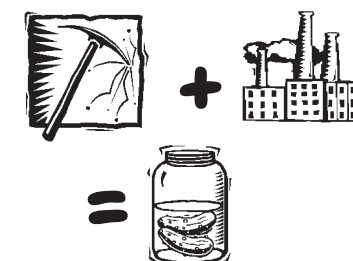


PICKLE PRODUCTION

Two goods are involved – the pickles and the glass container.

In the **natural resources sector**, a *sandstone quarry business* mines sandstone for making glass jars. [A farming business must grow cucumbers to make pickles.]

In the **goods production sector**, a *glass jar factory* uses sandstone to make glass jars. The *pickle factory* makes pickles from cucumbers and puts them in glass jars.

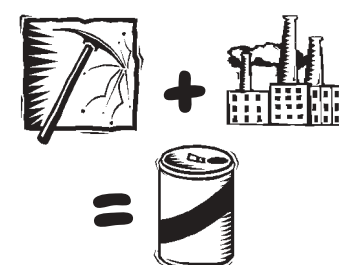


SODA POP PRODUCTION

Two goods are involved – the soda pop and the aluminum container.

In the **natural resources sector**, a *bauxite mining business* takes bauxite from extracted aluminum ore to make aluminum. [A farming business grows grapes, lemons and limes, etc. to make soda pop.]

In the **goods production sector**, an *aluminum can factory* makes aluminum cans. A *soda pop factory* makes soda pop and puts it in aluminum cans.

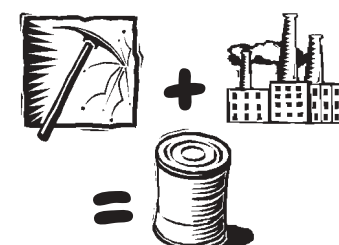


SOUP PRODUCTION

Two goods are involved – soup and the steel container.

In the **natural resources sector**, an *iron ore mining business* obtains iron ore. [A farming business grows plants or raises livestock to produce the ingredients to make soup.]

In the **goods production sector**, a *steel can factory* makes steel cans from iron ore. A *soup factory* makes soup and puts it in steel cans.



* Italics indicate businesses that are depicted on the model, *Econo-Puzzle* or *Econo-Community*.

** Brackets indicate businesses that are not depicted on the model, *Econo-Puzzle* or *Econo-Community*.



Econo-Community Model: Follow-up Questions

- 1 What do all of the businesses (and other places on the model) need?**

ANSWER: Energy and natural resources.

[Teachers may wish to review other sources of energy than the one (coal-electricity) highlighted on the model.]

- 2 What happens to recyclable materials after they have been collected by a recycling facility?**

ANSWER: Businesses, such as factories, buy the recycled materials to make containers or other products. (plastic bottle factory, paper factory, etc. in the goods production sector)

- 3 Why must recycled materials be separated in order to sell them to other businesses?**

ANSWER: Each business uses unique technological processes to make a specific type of material product. For example, aluminum can factories can only use recycled aluminum (or bauxite) in their processes to make aluminum cans; plastic bottle factories can only use recycled plastic (or natural plastic resin) to make plastic bottles.

- 4 How does the use of recycled materials reduce the amount of natural resources required to make products?**

ANSWER: Recycled material can be used in place of natural resources. Generally, some amount of natural resources is always required in production processes, even when recycled materials are used. The amount of

recycled material that can be used varies from high percentages in the case of steel and aluminum to lower percentages in the case of some paper and glass products, depending upon the production processes used and the quality of the product produced.

- 5 How does the use of recycled materials reduce the amount of energy required to make products?**

ANSWER: In the case of many production processes (e.g., aluminum and glass), lower furnace temperatures are required to melt recycled materials than are required to melt natural resources. Also, less energy is used to mine and transport resources when recycled materials are used. (In a few production processes, the use of recycled materials may actually require more energy. However, even in these cases, the energy used to mine and transport resources is reduced when recycled materials are used.)

- 6 What can people do to increase the amount of materials that are collected for recycling?**

ANSWER: People can become part of a recycling program at home or school. Most importantly, they can create an economic incentive to recycle within the market place by buying products made of recycled-content material.

GOODS, GARBAGE & RESOURCES

Directions: Put the correct letter in the blank space beside each question.

- _____ 1. Which of the following natural resources is required to make glass bottles?
- a. iron ore
 - b. sandstone
 - c. trees
 - d. bauxite
- _____ 2. Which of the following is an example of *production of a good*?
- a. A person hires someone to collect his or her garbage.
 - b. A person buys a bottle of soda pop.
 - c. A person uses a molding machine to make plastic bottles.
 - d. A person watches a television commercial about soda pop.
- _____ 3. Which of the following is an example of *consumption of a good*?
- a. A person hires someone to collect his or her garbage.
 - b. A person buys a bottle of soda pop.
 - c. A person uses a molding machine to make plastic bottles.
 - d. A person watches a television commercial about soda pop.
- _____ 4. Which example shows how recycling helps the environment?
- a. Producers use recycled materials instead of natural resources to make goods.
 - b. Consumers buy goods made from natural resources.
 - c. Producers use more natural resources and energy when they use recycled materials to make goods.
 - d. Garbage collectors take recyclables to the local landfill.
- _____ 5. What can people do to increase recycling?
- a. consume products made only from natural resources
 - b. consume products made from recycled material
 - c. consume a service which takes their garbage to a local landfill
 - d. consume a service which takes their garbage and burns it
- _____ 6. Aluminum can be used to make soda pop cans. What other product can be made from aluminum?
- a. glass bottles
 - b. plastic bottles
 - c. floor mats for automobiles
 - d. pie pans

GARBAGE GOODS

Inquiry

- What is necessary to operate a business and, in particular, what is necessary to operate a recycling business?

Content Domain

Social Studies – Economics

Learning Outcomes

Citizenship, Grade 4, #10, #11 and Grade 6, #12

Duration

Part A: 50 minutes (not including preparation of business boxes)

Part B: 50 minutes

Materials

Each student will need to bring in a **shoe box**. Each student or group of students will also need: **scissors, tape, glue, rubber bands** to secure shoe box lids, **coloring** and **writing materials, construction paper** and/or **plain paper**

Handouts

- *Starting Your Own Recycling Business*
- *Business Box Pictures*
- *Factors of Production*
- *Econo-Community* (from the previous activity, *Econo-Community*)
- *Business Box Labels*
- *Recycling and the Factors of Production*
- *Garbage Goods*

Activity
2**Business Boxes****Objective**

Students will be able to describe the factors of production necessary to operate any business and the specific “productive resources” needed to operate a recycling business.

Preparation

NOTE: This activity and the next one, *Enterprising Recycling*, are good follow-up activities to the concepts explored in the economic model (see *Econo-Community* handout, p. II-12) in the previous activity, *Econo-Community*. You may wish to review this activity, *Business Boxes*, and the next activity, *Enterprising Recycling*, to determine which you want to conduct, because both utilize the making of “business boxes” to teach students about the factors of production. However, the two activities are also different. *Business Boxes* is limited to teaching about the factors of production focusing on recycling centers as a business. The activity, *Enterprising Recycling*, is more complex; it focuses on producers of products and includes research, mathematical calculations, environmental impacts and controversial issues. If you have time, both activities may be conducted without repetition (except of important terms) and are compatible with each other.

Before the activity, have students prepare shoe boxes to become “business boxes.” Have each student write his/her name on the bottom of his/her own box. They should make the outside of the box as plain as possible. Words and

brand names should be covered.

Students can cover the outside of the boxes with construction paper, or use markers to cover existing details. Have students draw windows and a door on the outside of the box. Make sure students attach things or mark on the boxes so the lids will close.

Find the handout, *Econo-Community*, p. II-12, from the previous activity, *Econo-Community*. You will need to either make copies of this handout for students, or make an overhead transparency for the class to view.

You may find it useful to staple the handout, *Factors of Production*, from this activity to the handout, *Econo-Community*, for each student.

Procedure**PART A**

1 Assess students’ knowledge of the factors of production. If they already possess a good understanding of the factors of production, proceed with the steps that concentrate on the making of business boxes, which will assess each student’s understanding of the factors of production. To conduct pre-assessment, see the handouts referred to in the Assessment section.

2 Give each student the handout, *Starting Your Own Recycling Business*. Read the scenario and make sure everyone understands it.

3 Divide the students into groups and give each group, or each student in the group, the materials listed in the Materials section. Give each student his/her own business box (previously prepared) and the handout, *Business Box Pictures*.

4 As a class, read the directions at the bottom of the handout, *Starting Your Own Recycling Business*, and have students begin to draw pictures.

Students should share ideas with other members of their group, making inferences and discussing all the possible things needed to operate a recycling business. They should discuss what is needed as a group, with each learner making his/her own pictures. As students finish their pictures, have them place the pictures loosely in their business boxes. Each student in each group should have the same items in his/her box, but the drawings of each item should be made by each individual student. Refer to Part B, Step 4 for examples of picture items listed under LAND, LABOR and CAPITAL. If needed, prompt students who are having difficulty thinking of items on their own.

5 Have each group share their answers. As answers are being shared, students may wish to make pictures of items they did not think of. Make sure everyone has made pictures of each of the recyclable materials identified on the handout, *Starting Your Own Recycling Business*.

6 Students may keep all the materials, including their pictures, in their boxes. Secure the lids with rubber bands and store the boxes until they are used to complete the activity.

PART B

1 If students are unfamiliar with the factors of production, give each student a copy of the handout, *Factors of Production*, and review the definitions. It is not necessary to cover “raw materials” at the bottom of the page unless you find the distinctions useful.

2 After discussing the factors of production, use the handout, *Econo-Community*, from the previous activity, to help students answer the following questions and understand the role of land resources in the making of products.

- Recyclable materials are used in place of natural resources. Which natural resources can be replaced by recyclables?

ANSWER: glass instead of sandstone, aluminum instead of bauxite, plastic bottles instead of petroleum-generated plastic resin, paper instead of wood chips (trees), steel cans instead of iron ore.

- All of the natural resources on the handout are which factor of production? (land)
- Which factor of production do recyclables come under?

ANSWER: land. Although recyclables do not come directly from natural resources, a process of elimination and an understanding of the rules may help students answer this question. It should be obvious to students that recyclables are not *labor* or *entrepreneurship*.

Recyclable material is also not *capital* because of Rules 1 and 2 on the handout, *Factors of Production*. Recyclable material becomes part of the good being produced. Unlike items of capital, recyclables do not remain after they have been used.

- Energy in the form of electricity or natural gas, that is used to make products, is which factor of production?

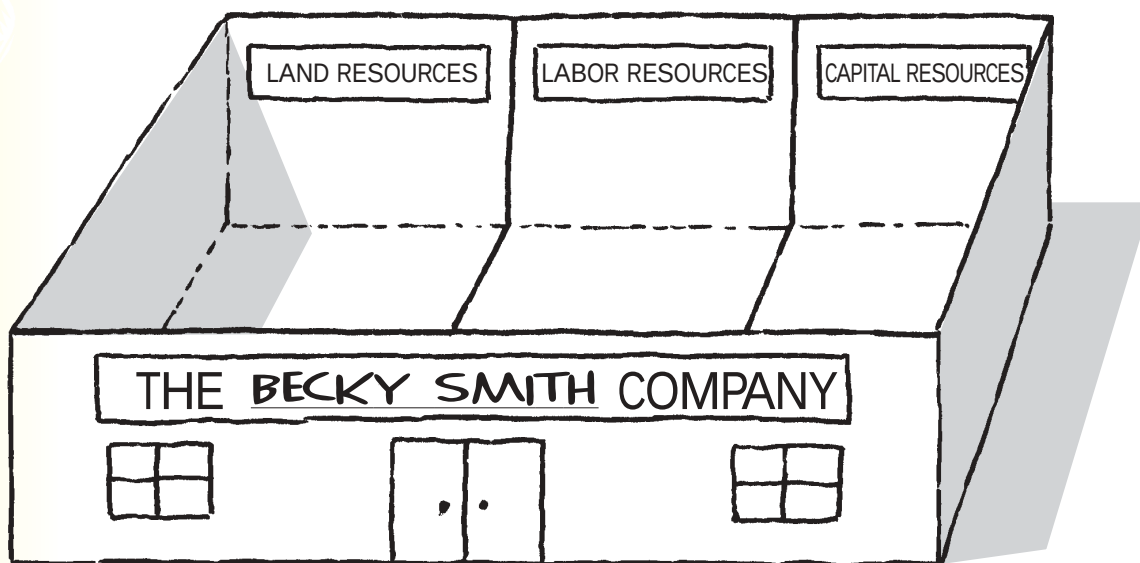
ANSWER: land. Again, see Rule 1. Energy is transferred into the product and becomes latent energy. For example, if old products, such as newspapers and plastic bottles, are burned, they release the latent energy that is stored in them.

3 Give each student his/her business box. This may be done individually instead of in groups because this part of the activity can serve as an assessment of each student’s understanding of the factors of production.

Students should take all pictures and materials out of their boxes. Have each student use a marker to divide the inside of the box into three equal sections, by drawing two lines from the top of one side (a long side, not a short side), down across the bottom and up the other side. (See illustration on next page.)

Give each student a set of labels from the handout, *Business Box Labels*. Have students cut out labels (LAND, LABOR, CAPITAL) and glue each one on the *inside* of the box, each label at the top of a different section, but on the same side of the box. Have each student cut out the blank sign and write his/her name between the words “The” and “Company” in the space provided. This can be glued anywhere on the outside of the box.

4 Have students examine each picture and decide in which factor of production section the picture should be placed in their business boxes. Have them lightly tape (temporarily) each picture in the appropriate section. Afterwards, you may evaluate each student’s box for assessment purposes.



The items identified below are possible answers.

LAND

- each of the recyclable items collected
- energy (electricity) to run machines
- wire to bale the paper and plastic bottles

LABOR

- people to operate machines
- people to sort materials
- receptionist
- drivers to collect recyclables and deliver them to a buyer
- someone (accountant) to record sales transactions

CAPITAL

- various machines to separate recyclables by materials
- machines to bale or bundle these materials so they can be loaded and shipped easily
- trucks to collect or deliver the recyclables to buyers
- Remember, the building itself– the business box– is capital

- 5 Select individual students to explain how they classified their items into the three categories. Make a master list of items for the class. Have students glue their previously taped pictures into the appropriate places in their boxes. In cases where students initially put examples in the wrong category, they may lift the tape and glue the picture in the proper section.

Assessment

- 1 Several forms are available. The handout, *Recycling and the Factors of Production*, provides a traditional assessment of student understanding of the factors of production.

ANSWERS: 1. d, 2. a, 3. b, 4. a, 5. d

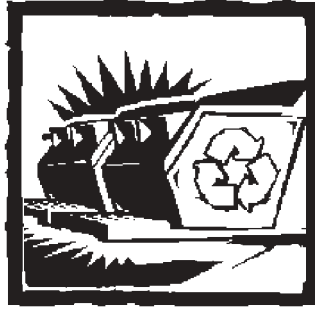
- 2 The handout, *Garbage Goods*, provides a non-traditional form of assessment requiring a rubric for grading.

- 3 A non-traditional form of assessment is embedded in the activity in Part B, Step 3.

Extension

Check with your local recycling agency to see if opportunities exist to take students on a field trip to a local recycling center. If this can be arranged, have students take notes while at the center to describe the factors of production they observe. After the field trip, have students compare their business box recycling operations with the recycling operation they visited.

Student Handout



STARTING YOUR OWN RECYCLING BUSINESS

You are a business person. You have been given a contract by the local government to collect recyclable items from all of the households in your community. Each household puts all of its recyclable items (*GLASS BOTTLES, ALUMINUM CANS, PLASTIC DETERGENT BOTTLES* and *PLASTIC MILK BOTTLES, PAPER ITEMS, and STEEL CANS*) in one container for you to collect. Each household puts the rest of its garbage in another container to be taken by another business to the local landfill.

In order to sell your recycled materials, you need to prepare the recyclables the way that the buyers request. Here are descriptions of how each buyer wants you to prepare the material:

- A glass bottle maker will buy your recycled glass if it is ground up into small $\frac{1}{4}$ inch pieces and put in barrels.
- An aluminum can maker will buy your recycled aluminum cans if you flatten and squeeze them (about 1,000) into bricks that weigh 35 pounds each.
- A plastic bottle maker will buy your plastic detergent bottles and milk jugs if you shred them into long, thin pieces and wrap the pieces tightly into bales (about the size of a refrigerator) wrapped with wire.
- A paper tablet maker will buy your paper if it is not wet or dirty and if you squeeze 800 pounds of paper (junk mail, newspaper, notebook paper, etc.) into a bale (about the size of a refrigerator) wrapped by wire.
- A steel can maker will buy your steel cans if you put them into a big truck bed.

BUSINESS BOX DIRECTIONS: Make pictures of the things you need to operate your recycling business. Draw each picture in a single square on the handout, *Business Box Pictures*. In the space within each square, write what the picture is. Make each picture about one thing only. For example, if you draw a picture of a machine, draw a separate picture of a person who operates the machine. Do not make a single picture of a person and a machine together.

Student Handout

BUSINESS BOX PICTURES

Directions: Cut out each square along the dotted lines and draw a picture in the bottom of the square. Tell what the picture is in the top part of each square.

FACTORS OF PRODUCTION

Anyone who owns a business must consider four factors of production in order to manage the business. Each factor of production includes **PRODUCTIVE RESOURCES** that are often referred to as just **RESOURCES**. Definitions of the four factors of production and specific examples of resources related to each factor are provided below.

Land

Land includes resources that occur in nature such as trees, minerals (iron ore, coal, oil, copper, etc.), water, soil, plants and animals. The land factor of production therefore includes all **NATURAL RESOURCES**.

RULE #1: Land resources become a part of the good being produced.

Labor

Labor includes the resources that people possess such as knowledge, skills, special talents and physical abilities. The labor factor of production may also be called **HUMAN RESOURCES**.

Capital

Capital includes resources, such as tools, machines, buildings and vehicles, used to produce a good or service. (Capital is not money. Sometimes money is called “financial capital,” but do not confuse it with “capital” as a factor of production. Capital refers to things the producer buys with money.) Many types of capital are **TECHNOLOGY RESOURCES**.

RULE #2: Capital resources do not become a part of the good being produced.

Entrepreneurship

Entrepreneurship refers to the ability of a person to start a business that makes a product or provides a service. It includes the ability of a person to make decisions about the other factors of production. Success in business is based on using factors of production to make a profit from selling a good or service.

Raw Materials

Raw materials are land factors of production that are used to make products. They can be natural resources, such as the iron ore used to make sheets of steel. Or, they can be processed materials, such as the sheets of steel used to make washing machines, cans and other steel products. All raw materials that come directly from natural resources are called **PRIMARY MATERIALS** (primary raw materials). Raw materials that come from the garbage, such as steel cans and old washing machines, are called **SECONDARY MATERIALS** (secondary raw materials).

BUSINESS BOX LABELS

LAND RESOURCES

LABOR RESOURCES

CAPITAL RESOURCES

THE _____ COMPANY

LAND RESOURCES

LABOR RESOURCES

CAPITAL RESOURCES

THE _____ COMPANY

RECYCLING AND THE FACTORS OF PRODUCTION

Directions: Put the correct letter in the blank space beside each question.

- _____ 1. Ralph Goodguy, who manages the local recycling collection center, bought a magnetic separator to sort aluminum cans from steel cans. What factor of production is a magnetic separator?
- a. land
 - b. labor
 - c. entrepreneurship
 - d. capital
- _____ 2. Machines that separate different materials like steel cans from aluminum cans are important to a recycling business because:
- a. a business that uses recycled material to make a new product will buy only one type of material from a recycling business
 - b. a business that uses recycled material to make a new product will buy several types of materials from a recycling business
 - c. businesses that make machines that separate materials need recycling businesses to buy their products
- _____ 3. Cathy Goodgirl owns a factory that makes aluminum. She has decided to buy recycled aluminum cans to make aluminum. She decided to do this because making aluminum from recycled aluminum cans costs less than making it from bauxite. Cathy's decision to do this is an example of which factor of production?
- a. land
 - b. entrepreneurship
 - c. capital
 - d. labor
- _____ 4. Recycled materials are an example of which factor of production?
- a. land
 - b. entrepreneurship
 - c. capital
 - d. labor
- _____ 5. Bill Workhard operates the paper baler at the local recycling center. He also drives a truck to collect recyclables. He is an example of which factor of production?
- a. land
 - b. entrepreneurship
 - c. capital
 - d. labor



GARBAGE GOODS



You have been given 10 tons of garbage and trash from your local community waste collector.

What could you do and what things would you need to start a recycling business and sell some of this garbage and trash? Write a short paragraph to explain your answer. Include the following words in your explanation if you know what they mean: *LAND, LABOR, CAPITAL, ENTREPRENEURSHIP, RECYCLED MATERIALS.*



Enterprising Recycling

Objectives

Students will be able to: (a) identify the factors of production and describe recyclable material as a factor of production; (b) explain how production decisions are made regarding the use of recycled materials; (c) identify the natural resources used to make products; and (d) identify the environmental impact of using recycled materials.

Preparation

NOTE: This activity and the previous one, *Business Boxes*, are good follow-up activities to the concepts explored in the economic model (see *Econo-Community* handout, p. II-12) in the previous activity, *Econo-Community*. You may wish to review *Enterprising Recycling* and the previous activity, *Business Boxes*, to determine which to conduct, because both utilize the making of “business boxes” to teach students about the factors of production. However, the two activities are different. *Business Boxes* is limited to teaching the factors of production and focuses on recycling centers as a business. This activity, *Enterprising Recycling*, is more complex; it focuses on producers of products and includes research, mathematical calculations and environmental impacts. If you have the time, both activities may be conducted without repetition (except of important terms) and are compatible with each other.

Before the activity, have students prepare their shoe boxes to become “business boxes.” Have each student write his/her name on the bottom of the box. They should make the outside of the box as plain as possible. Words and

brand names should be covered. Students can cover the outside of the boxes with construction paper, or use markers to cover existing details. Have students draw windows and a door on the outside of the box. Make sure students attach things or mark on the boxes with the lids closed.

Four handouts from the previous two activities will be useful when conducting this activity. These handouts are:

Econo-Community, p. II-12, from the activity, *Econo-Community*. This is a model of the economic production-consumption system that students will need in order to make decisions in this activity. Make an overhead of this handout so all students can see it, or make copies for each student.

Factors of Production, p. II-21, from the activity, *Business Boxes*. This handout contains definitions of terms that are reinforced throughout the activity. Make a copy for each student. (You may find it useful to staple the handout, *Factors of Production*, to the *Econo-Community* handout for each student.)

Business Box Labels, p. II-22, and *Business Box Pictures*, p. II-20 , from the previous activity, *Business Boxes*.

Inquiries

- What happens to recycled materials after they have been collected?
- Why do producers use recycled materials to make new products?
- How can the use of recycled materials in production processes benefit the environment?

Content Domain

Math – Arithmetic

Science – Natural resources

Social Studies – Economics

Learning Outcomes

Citizenship, Grade 4, #10, #11 and Grade 6, #12, #13

Math, Grade 4, #4, #8, #11 and Grade 6, #3, #6

Science, Grade 4, #14

Duration

Part A: 50 minutes (not including preparation of business boxes)

Part B: 50 minutes

Materials

Each student will need to bring in a **shoe box**. Each student or group of students will also need: **scissors, tape, glue, rubber bands** to secure shoe box lids, **coloring and writing materials, construction paper** and/or **plain paper**

continued next page

GARBAGE GOODS

Handouts

From Activity 1,
Econo-Community:

- *Econo-Community*

From Activity 2, *Business Boxes*:

- *Business Box Labels*
- *Business Box Pictures*
- *Factors of Production*

From this activity:

- *Production Costs*
- *Business Management Planning*
- *Business Management Planning Answers*

From this activity, make copies of the handouts, *Production Costs* and *Business Management Planning*, for each student. Staple these together.

Procedure

PART A

1 Assess students' knowledge of the factors of production. If they already possess a clear understanding of the factors of production, proceed with the steps that concentrate on making business boxes, which can serve to assess each student's ability to apply an understanding of the factors of production. To conduct pre-assessment, see the handouts referred to in the Assessment section, p. II-18, of the previous activity, *Business Boxes*.

2 If students are unfamiliar with the factors of production, give each student a copy of the handout, *Factors of Production*, and review the definitions. Be sure to cover the concept of "raw materials" at the bottom of the page.

3 After discussing the factors of production, have students answer the following questions. Use the handout, *Econo-Community*, to help students answer the questions and understand the role of land resources in the making of products.

- Recyclable materials are used in place of natural resources. Which natural resources can be replaced by recyclables?

ANSWER: glass instead of sandstone, aluminum instead of bauxite, plastic bottles instead of petroleum-generated plastic resin, paper instead of wood chips (trees), steel cans instead of iron ore.

- All of the natural resources on the handout are which factor of production? (land)
- Which factor of production do recy-

clables come under?

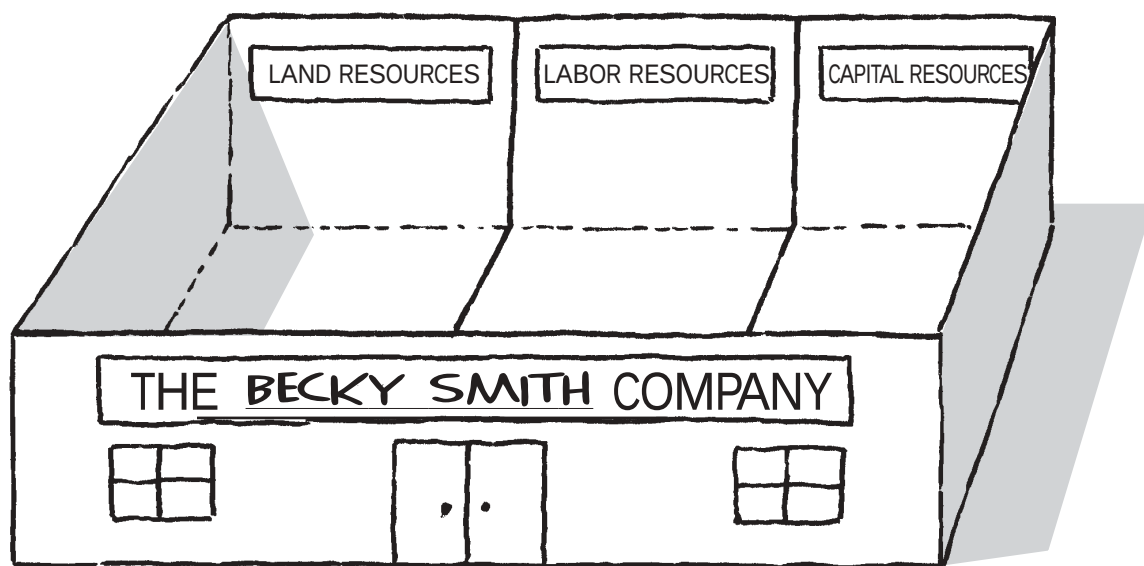
ANSWER: land. Although recyclables do not come directly from natural resources, students can use process of elimination and an understanding of the rules to answer this question. It should be obvious to students that recyclables are not *labor* or *entrepreneurship*.

Recyclable material is also not *capital* because of Rules 1 and 2 on the handout, *Factors of Production*. Recyclable material becomes part of the good being produced. Unlike items of capital, recyclables do not remain after they have been used.

- Energy in the form of electricity or natural gas, that is used to make products, is which factor of production?

ANSWER: land. Again see Rule 1. Energy is transferred into the product and becomes latent energy. For example, if old products, such as newspapers and plastic bottles, are burned, they release the latent energy that is stored in them.

4 On the handout, *Econo-Community*, identify the businesses that make products directly from natural resources or from recycled materials (steel can factory, paper factory, aluminum can factory, glass jar factory, and plastic bottle factory – in the bottom row of the "goods production" section). Ask students what these businesses need in order to make their products (natural resources, energy, labor, machines, etc.). Explain to students that the activity they are about to do will help them understand how business people, or entrepreneurs, make production decisions and why businesses may be motivated to use recycled materials in production processes. Have students trace the life of a plastic bottle, aluminum can, etc. by making inferences from the model.



5 Divide students into five groups of four or five students each. Designate each group to be one of the five businesses listed in the bottom row of the “goods production” section on the handout, *Econo-Community*. Use all five businesses (steel can factory, paper factory, aluminum can factory, glass jar factory and plastic bottle factory).

6 Give each student his/her business box, previously prepared per instructions in the preparation section. Each student in each group will construct his/her own business box as described below. Each student in each group will be making the same business, with a different business for each group.

7 Business boxes should be constructed in the following manner: Have each student use a marker to divide the inside of the box into three equal sections, by drawing two lines from the top of one side (a long side, not a short side), down across the bottom and up the other side. (See illustration above). Give each student a set of labels from the handout, *Business Box Labels*. Have students cut

out labels (LAND, LABOR, CAPITAL) and glue each one on the inside of the box, with each label at the top of a different section, but on the same side of the box. Have each student cut out the blank sign and write his/her name between the words “The” and “Company” in the space provided. This can be glued anywhere on the outside of the box.

8 Using encyclopedias, web sites and other reference material, have students research each of the factors of production involved in making their products. Groups should work together to make lists of productive resources. As resources are identified, have each student in the group make a picture of the item and tape it inside his/her business box in the appropriate factor of production section. Pictures can be made using the handout, *Business Box Pictures*. For each square there is space at the top to identify the picture. Have students lightly tape (temporarily) each picture and afterwards evaluate each group’s boxes for the correct placement of resources. Students can then glue the resources in permanently.

PART B

1 Give each student a copy of the handout, *Production Costs*. Review this sheet and have students fill in the blanks as you go over it. Students will need to refer to the handout, *Econo-Community*, to help fill in some of the answers. The first thing they can do is identify the good produced by their business and write the name of this good (steel cans, plastic bottles, etc.) in all of the spaces indicated on the handout, *Production Costs*.

2 Students will need to refer to the handout, *Production Costs*, to derive figures to record on the handout, *Business Management Planning*. You may want to staple these together as suggested in the Preparation section. The handout, *Business Management Planning Answers*, provides answers to the handout, *Business Management Planning*.

3 Refer students to the first row under “Production Choices” (Q = 1,000) on the handout, *Business Management Planning*. Help students figure all the costs associated with producing 1,000 items of their prod-

uct, filling in all of the blocks in the first row under land, labor, capital, revenue, etc. Remember, the answers are to be found by referencing the handout, *Production Costs*. Calculate as follows:

LAND

Students need to buy 2 units of **raw materials** to make 1,000 items.

$$(2 \text{ units} \times \$5.00 = \$10.00)$$

Have students put \$10.00 in the RAW MATERIAL square, row 1.

Students need to buy 2 units of **energy** (electricity to run the machine) to make 1,000 items.

$$(2 \text{ units} \times \$5.00 = \$10.00)$$

Have students put \$10.00 in the ENERGY square, row 1.

LABOR

Students need to buy 2 units of **labor time** to pay someone to operate the machine(s) long enough to produce 1,000 items.

$$(2 \text{ units} \times \$10.00 = \$20.00)$$

Have students put \$20.00 in the LABOR square, row 1.

CAPITAL

Students need to buy a **building** and **machine** to make their product. They need to buy a building which costs \$50.00 and a machine which costs \$50.00.

$$(\$50.00 + \$50.00 = \$100.00)$$

Have students put \$100.00 in the CAPITAL square, row 1.

It may appear that \$100.00 is rather cheap for machine and building costs. These costs may be considered from the perspective of costs per day, and all “Production Choices” are based on production choices for one day.

Students now add up their total costs to make 1,000 items of their product. Have them put \$140.00 in the TOTAL COSTS square for Production Choice #1.

In the REVENUE square, students should put \$140.00 per the sale of 1,000 items (one batch). Have students now calculate profit or loss. (They broke even.)

Ask students which resources they used up when making their 1,000 items (raw materials, energy, labor time). Why isn’t the machine “used up”? The machine can make 1,000,000 items before it must be replaced (or repaired). Most capital items, such as buildings and machines, are permanent features of a business, unlike land and labor resources which are used up and must be acquired continually. This is why capital costs are considered “fixed costs” as indicated on the handout, *Business Management Planning*. Land and labor costs vary with production and are called “variable costs” as indicated on the handout.

4 Ask students if they see any way they could make a profit by considering the nature of costs as understood so far. See if anyone recognizes the value of fixed costs relative to producing more product.

5 Have students in their groups calculate costs, revenue and profit potential if they boost production to 2,000 items of product. Have them calculate these figures for both 2,000 items produced using natural resources, Production Choice #2 and 2,000 items produced using recycled material, Production Choice #3. Refer to the handout, *Business Management Planning Answers*, which indicates how using recycled materials can cut production costs and enhance profits.

6 Discuss the issues associated with economics, environmental concerns and recycling. Continue with further mathematical problem solving, if desired. Sample questions follow.

Economics

What economic factors create incentives for the use of recycled materials by producers? (cost reduction, buyer willing to pay the same price for recycled material as for virgin products, consumers must ultimately demand or buy recycled-content products, etc.)

Environment

How can good economic practices also be good for the environment? (save resources and energy) What would happen in this scenario if recycled materials cost more than virgin materials? Is energy savings enough to reduce costs sufficiently to use recycled materials?

Mathematics

Have students calculate per item (each item of a batch of 1,000) costs and percentages of total cost of each factor of production, etc. Given that recycled materials cost say, 50 cents more than natural resources, is the amount of energy savings that can be realized enough to reduce costs?

Assessment

To assess students’ knowledge about the factors of production you can use the handout, *Recycling and the Factors of Production*, in the activity, *Business Boxes*, p. II-23. To assess students’ understanding of the math concepts in the activity, use the blank rows 4 and 5 on the handout, *Business Management Planning*, to construct additional math problems associated with producing varying amounts of product.

Student Handout

PRODUCTION COSTS

- 1 What is the good that you produce? _____

LAND RESOURCES: Natural Resources

- 2 What natural resource raw material is required to make your good? _____
COSTS: One unit of natural resource raw material costs \$5.00.
- 3 It takes two units of natural resource raw material to make a batch of 1,000 _____
(good you produce)
- 4 It takes two units of energy to make 1,000 _____ from _____
COSTS: One unit of energy costs \$5.00. (good you produce) (natural resource you use)

LABOR RESOURCES:

You need to hire a person to operate the machine that makes your product and pay the employee for the time he or she spends operating the machine.

- 5 It takes two units of labor time to make 1,000 _____
COSTS: One unit of labor time costs \$10.00. (good you produce)

CAPITAL RESOURCES:

You need a building in which to make your product. You need a machine to make your product.

- 6 You can make 1,000,000 _____ with the building and machine.
(good you produce)
COSTS: The building costs \$50.00. The machine costs \$50.00.

REVENUE:

- 7 Who will buy the good you produce? _____
- 8 This buyer will pay you \$140.00 for each batch of 1,000 _____
(good you produce)

LAND RESOURCES: Recycled Materials

- 9 What type of recycled material can you use to make your good? _____
COSTS: One unit of recycled material costs \$2.50.
One unit of recycled material can be used instead of one unit of natural resource.
- 10 You can only use one unit of recycled material for each batch of 1,000 _____
(Only 50% of your product can be recycled material.) (good you produce)
- 11 When you use recycled material, it takes only one unit of energy instead of two units to make a batch of 1,000 _____
(good you produce)

BUSINESS MANAGEMENT PLANNING

PRODUCTION CHOICES	VARIABLE COSTS			FIXED COSTS	VARIABLE + FIXED COST	# batches ✕ market price	REVENUE - COSTS
	LAND		LABOR				
	Raw Material	Energy		CAPITAL	TOTAL COSTS	SALES REVENUE	PROFIT 😊 OR LOSS 😞
Q=1,000 (1 batch)							
Q=2,000 (2 batches)							
Q=2,000 (2 batches with recycled material)							

BUSINESS MANAGEMENT PLANNING ANSWERS

PRODUCTION CHOICES	VARIABLE COSTS			FIXED COSTS	VARIABLE + FIXED COST	# batches x market price	REVENUE - COSTS
	LAND		LABOR CAPITAL				
	Raw Material	Energy					
Q=1,000 (1 batch)	\$10.00	\$10.00	\$20.00	\$100.00	\$140.00	\$140.00	.00
Q=2,000 (2 batches)	\$20.00	\$20.00	\$40.00	\$100.00	\$180.00	\$280.00	\$100.00
Q=2,000 (2 batches with recycled material)	\$15.00	\$10.00	\$40.00	\$100.00	\$165.00	\$280.00	\$115.00

THE PAPER FACTORY

Environmental Studies Learning Concept

Historically, technological advances have increased energy consumption.

Increased energy availability has enabled the development of advanced technologies, some increasing and some reducing energy requirements as compared to older technologies. Advances in technology have brought concerns about energy and resource conservation.

Recycling is part of the technological and industrial process. Using recycled materials in production processes generally reduces the energy needed to make new products and may reduce the energy required to extract and process raw materials. This in turn reduces the energy costs of manufacturers. Many manufacturing processes rely on non-renewable energy sources, but the demand for this type of energy can be reduced when manufacturers use secondary materials.

Recycling imparts economic value to what would otherwise be a waste material requiring disposal. Recycled material (secondary material) is economically valuable because it is part of an industrial process that conserves energy and non-renewable resources, thereby reducing production costs.

Vocabulary

advertisement – information that a business provides about its products or services

base paper – material that is added to water to make recycled paper; different bases may include newspaper, tissue, computer paper

consumer – a person who buys a product or a service

demand – how much something is wanted, particularly in regard to consumers purchasing goods

disposal – the process by which waste is prepared for its final containment or destruction

energy – the ability to perform work or produce a change

entrepreneur – a person who starts a business and makes decisions about the use of economic resources in order to make a profit

goods – products that can be bought or sold

grade – a classification system for paper products, uses fiber strength and color as determining factors

human resources – people who work for a company

manufacturing – the process of turning raw materials into finished products, usually with the aid of machines

marketing – planning how to sell a product

natural resource – a material source of wealth, such as timber, freshwater, wildlife or a mineral deposit that occurs in nature

paper – a thin sheet of material made of cellulose pulp, derived mainly from wood, but can be made from textiles and certain grasses

paper pulp – a mixture of cellulose material that is ground up and moistened to make paper

price – the cost to buy a product or service

product – something that people make or grow, often to sell

production – the process of making or manufacturing a product for sale or trade

raw materials – resources needed to make a product; may be natural resources or recycled materials

recycling – to collect and process waste materials for use in manufacturing new products

reuse – to use again; to extend the life of an item by repairing it or by creating new uses for it

service – something one person does for another

solid waste – discarded garbage and trash

supply – the amount of a product or service available for sale

technology – the use of machines, tools and materials to make products faster and more easily

wages – money that is used to pay workers

waste – anything that is worthless or useless; material which cannot be reused or recycled and must be disposed of

work – actions of humans and/or machines that require energy

Overview - THE PAPER FACTORY



Activity 1: Papermaking

1

Description

Students *cooperate* in groups to produce a paper product using recycled paper or a natural resource. After making their product, students decorate their paper and then *analyze* the process, which includes identifying materials and their costs. Each group gathers information to assign energy and monetary value to the materials they used in order to compute the cost of their paper product. Using this cost information, students *make deductions* about the effectiveness of recycling in saving money and energy.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #4 – Identify needed information to solve a problem.

Grade 4, Mathematics #5 – Explain or illustrate why a solution is correct.

Grade 4, Mathematics #8 – Add, subtract, multiply and divide whole numbers and explain in words thinking strategies for making computations.

Grade 4, Mathematics #24 – Make or use a table to record and sort information and make identifications, comparisons and predictions from tables, graphs, bar graphs and labeled picture maps.

Grade 4, Science #1 – Create and/or use categories to organize a set of objects, organisms or phenomena.

Grade 4, Science #4 – Use a simple key to distinguish between objects.

Grade 4, Science #6 – Evaluate a simple procedure to carry out an exploration.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Summary

This lesson includes three activities. The first is the introductory activity, which teaches students how to make paper. The second activity can be done with the first activity because it involves sorting recycled paper from trash. The papermaking knowledge gained in the first activity is essential to conducting the last activity, when students establish their own mock papermaking companies.

Activity 2: What Sort of Trash is This Anyway?

2

Description

Students *manipulate* trash items, *classify* them using a dichotomous key and *identify* which materials can be recycled and which materials, when recycled, can be made into paper. This activity also includes a vocabulary puzzle.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #24 – Make or use a table to record and sort information and make identifications, comparisons and predictions from tables, picture graphs, graphs, bar graphs and labeled picture maps.

Grade 4, Science #1 – Create and/or use categories to organize a set of objects, organisms or phenomena.

Grade 4, Science #4 – Use a simple key to distinguish between objects.

3

Activity 3: The Paper Company

Description

Students use what they learned about recycling paper to *develop a plan* to establish companies to produce recycled paper products and sell their products to a partner class. They *implement their plan* and *work cooperatively* to *gather materials*, *compute costs* and *manipulate materials* to create a paper product. To sell their product, students use *creative writing* to create advertisements.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #4 – Identify needed information to solve a problem.

Grade 4, Mathematics #5 – Explain or illustrate why a solution is correct.

Grade 4, Mathematics #8 – Add, subtract, multiply and divide whole numbers and explain in words thinking strategies for making computations.

Grade 4, Science #1 – Create and/or use categories to organize a set of objects, organisms or phenomena.

Grade 4, Science #6 – Evaluate a simple procedure to carry out an exploration.

If extension is done, the following apply:

Grade 4, Citizenship #10 – Identify the factors of production (land, labor, capital and entrepreneurship) needed to produce various goods and services.

Grade 4, Citizenship #11 – Name the resources needed to produce various goods and services, classify each resource by the factors of production, or suggest alternative uses for those factors.

Grade 6, Citizenship #12 – Describe the role of each factor of production in producing a specific good or service and suggest alternative uses for the resources involved.

Background Information

Human activity and the environment is a proficiency concept that runs through every age group. Respect for the environment and our use of it, is integral to the concept of recycling. Why recycle? This is a question that is both economic and environmental.

Does recycling save energy and resources? The argument that recycling saves energy and natural resources is undeniable for metals like aluminum and steel. When discussing how paper recycling saves natural resources, the answer is not as clear. It can be argued that trees are a renewable resource. Further, many of the trees used for paper are specifically planted for that purpose and would not be planted if they were not needed to make paper.

However, it is easier to demonstrate how recycling paper saves land space and energy. Recycled paper products are diverted from landfills, saving land space. Making new paper from old paper takes less energy than cutting and processing trees. Answering the following questions gives further cause to support paper recycling: Why recycle? What do you value? Should we throw usable materials away?

To understand the issues involved in paper recycling, students need to understand how recycled paper is used. Recycled paper products can be made from a variety of **base papers**. Cereal boxes can be recycled into drink carriers or egg cartons. Office paper can be recycled into school paper, toilet paper or paper towels. Newspaper can be recycled into corrugated cardboard and cereal boxes.

Each time paper is recycled it becomes a lesser **grade** (a classification of paper), which means it goes from a smooth, tightly woven paper with a certain amount of strength to a heavier or looser weave paper. For example, office paper requires a higher grade of recyclable paper than cereal boxes.

When students are given a chance to look at the recycling process and compare the use of natural resources to recycled resources, they are given the knowledge to make decisions that affect the environment. They are also given the opportunity to see that there are no easy answers and that we, as a society, have to decide what we value. By choosing to recycle, students will learn they can make a difference in their own homes and schools.

Bibliography and Additional Resources

Student Resources

50 Simple Things Kids Can Do To Recycle, by John Javna, The Earth Works Group and the Ohio Department of Natural Resources, 1994.

From Tree to Paper, by Wendy Davis, New York: Scholastic, 1995.

Media

Step into the World of Papermaking, (video) may be obtained from Georgia-Pacific Papers, 1994.

How Paper Recycling Works, 12 minutes, grades 7-12, American Paper Institute, 1995.

Educator Information

Facts Not Fear, A Parent's Guide to Teaching Children About the Environment, by Michael Sanera and Jane S. Shaw, Washington, DC: Regency Publishing, Inc., 1996.

Mastering the Economics Concepts, Ohio Grade 6 Citizenship Proficiency Test, The Greater Cincinnati Center for Economic Education, University of Cincinnati, 1995.

THE PAPER FACTORY

Activity
1

Inquiries

- How is recycled paper made?
- How can energy be saved by using recycled paper?
- How can we identify energy saved when using recycled materials in a production process?

Content Domain

Math – Arithmetic (problem solving)

Science – General and physical science

Learning Outcomes

Math, Grade 4, #4, #5, #8, #24

Science, Grade 4, #1, #4, #6, #14

Duration

Part A: 45-60 minutes

Part B: 45-60 minutes

Materials

Part A: Blender, base paper (newspaper, colored construction, colored tissue, toilet tissue), warm water, two large bowls, candy molds, wire strainer, dish pans, screens (see instructions), whisk, newspaper, tablespoons, 2-cup measure, Argo powdered laundry starch, yarn, potpourri

Part B: Paint, glitter, yarn, markers, doilies, ribbon and assorted materials for decoration

continued next page

Papermaking

Objectives

Students will be able to: (a) identify the resources needed to produce a paper product and describe alternative resources that can be used to produce paper; (b) explain the role of energy in a production process; (c) make deductions about the effectiveness of recycling in saving money and energy; and (d) analyze the costs and benefits of alternative consumer choices.

Preparation

Part A: Gather materials. Read over instructions and papermaking tips on the handout, *How to Make Paper*. Cover work area with newspaper.

Part B: This needs to be done after the paper products have dried, approximately two days after papermaking. Gather materials. Cover tables for each group. Make an overhead of the handout, *Papermaking Cost-Analysis Sheet*.

Procedure

PART A

1 Explain how recycling paper requires a physical change, first by tearing and then by liquefying. Compare the physical change that paper goes through with other physical changes, like melting and freezing. Explain that each student will be a member of a group that will make paper products.

2 Divide students into five groups. Each group will have a different base and group procedure (see the teacher handout, *Papermaking Groups*). Make

sure that at least one group has a base that is labeled “natural resource” (this correlates to using trees to make paper) and at least one group uses a base that is a “recycled resource.”

3 Give each group their base material and have them shred their material until they have two cups.

NOTE: During papermaking it is usually easier if one group at a time works on making paper. The other groups can complete Activity 2, *What Sort of Trash is This Anyway?*

4 Have groups follow the directions on the handout, *How to Make Paper*. They will make a paper pulp using either a whisk or blender.

NOTE: Groups using the whisk may want to soak their paper in warm water.

5 Students may add items to their pulp as directed on their group sheet.

6 Students will then use their pulp to make paper. Each group should use all of their pulp to make as many paper products as they can. This is important when they do the comparisons in Part B.



7 Each group should save all of their waste products. Place them in a corner of the room labeled with their group number or give each group a bag.

PART B

1 Put students into their paper-making groups and have them gather their group's products and waste bag.

2 Allow students to decorate their paper products. Advise them that there will be a cost for decorations and that they need to keep track of what they use.

3 After students finish decorating their products, have them complete the handout, *Papermaking Cost-Analysis Sheet*. Each item students used during the papermaking process will have money and energy related to its use. These money and energy costs can be found on the handout, *Materials Cost Sheet*. Using an overhead of the handout, *Papermaking Cost-Analysis Sheet*, do an example for the class that includes some items from each cost category and show students how to record and add costs. When working on the example (on the overhead), compare costs of recycled and natural base materials to show how values for natural resources and recycled resources differ.

4 Have groups complete the handout, *Papermaking Cost-Analysis Sheet*, including all costs related to their products. Each group will need a copy of the handout, *Materials Cost Sheet*, to determine their costs. When the groups have listed all their costs, have them add the figures to find their total energy and total money costs. Then the groups will add their money and energy totals to calculate their total cost. They will list the number of products they made. Then have them divide to find the cost of each paper product. They may round and use estimation, if needed.

5 Have groups answer the last two questions on the handout, *Papermaking Cost-Analysis Sheet*.

6 Have each group report to the class the number of products they made, their total cost and the cost per product.

7 As a class, discuss the reports. Compare costs and products. As a class, answer the last two questions on the handout, *Papermaking Cost-Analysis Sheet*.

Questions for Discussion

- How did the groups using natural resource material compare to the recycled resource groups?
- How did their money total and energy total compare?
- Did using recycled materials save money and energy?
- Which group could make the most profit and how?
- Which product would seem the best?
- If natural resources have a value of one, could we make the statement that recycled materials save energy and resources?

Assessment

Assessment of this activity can be done in a variety of ways. Embedded assessment is provided with the student-produced paper product and student explanation of resources needed to produce a paper product.

By using the handout, *Steps in the Papermaking Process*, students can demonstrate their knowledge of the papermaking process.

ANSWERS to *Steps in the Papermaking Process*:

THE PAPER FACTORY

Handouts

Part A:

- [Papermaking Groups](#)
- [How to Make Paper](#)
- [Recycled Paper Jewelry](#)

Part B:

- [Papermaking Cost-Analysis Sheet](#)
- [Materials Cost Sheet](#)
- [Steps in the Papermaking Process](#)

- (1) Bales of paper enter mill.
- (2) Paper is shredded.
- (3) Paper is mixed with water in a digester/hydropulper.
- (4) Paper is poured onto a screen.
- (5) Paper is dried and rolled.
- (6) Paper is made into new products.

You may also ask students the question: Knowing what you do about the costs of producing a paper product, what changes will you make to increase productivity and reduce material costs for your final project? Evaluate their answers using a class-created rubric.

Extension

Have students graph information from the handout, *Papermaking Cost-Analysis Sheet*.

PAPERMAKING GROUPS

Group #1

Base -----newspaper (recycled resource)
Tools -----blender
Method -----pour
Shaping-----screens
Additives -----colored tissue, potpourri

Group #2

Base -----colored scrap construction paper (recycled resource),
combine colors (only slightly blended paper will show
flecks)

Method -----pour
Shaping-----screens
Additives -----none

Group #3

Base -----colored tissue paper (represents natural resource
because it has not served another use)
Tools -----whisk
Method -----pour
Shaping-----screens
Additives -----potpourri

Group #4

Base -----toilet paper (natural resource)
Tools -----whisk
Method -----pour
Shaping-----screens
Additives -----string, dryer lint, yarn, feathers

Group #5 (Follow instructions on the handout, Recycled Paper Jewelry)

Base -----newspaper
Tools -----blender
Method -----hand filling
Shaping-----candy molds
Additives -----starch

Student Handout

HOW TO MAKE PAPER

MATERIALS

base paper
warm water
2 large bowls

wire strainer
dish pans
screens
(see instructions)

whisk
blender
plastic canvas
newspaper

2-cup measure
colored tissue
string, yarn, feathers,
lint

INSTRUCTIONS FOR MAKING SCREENS:

Use wooden or plastic embroidery hoops. Cut polyester window screening to fit the hoops, leaving excess so the screens can be tightened if they loosen up. Cut plastic canvas to fit the opening in the hoop.

1 Tear the base paper into small pieces measuring about 2 cups.

2 TOOLS:

- If using a whisk, put paper and 3 cups of warm water into a bowl. Let soak for at least 20 minutes. Stir with whisk.
- If using a blender, fill blender half full of warm water. Add 2 cups of paper. Blend until the consistency of oatmeal.

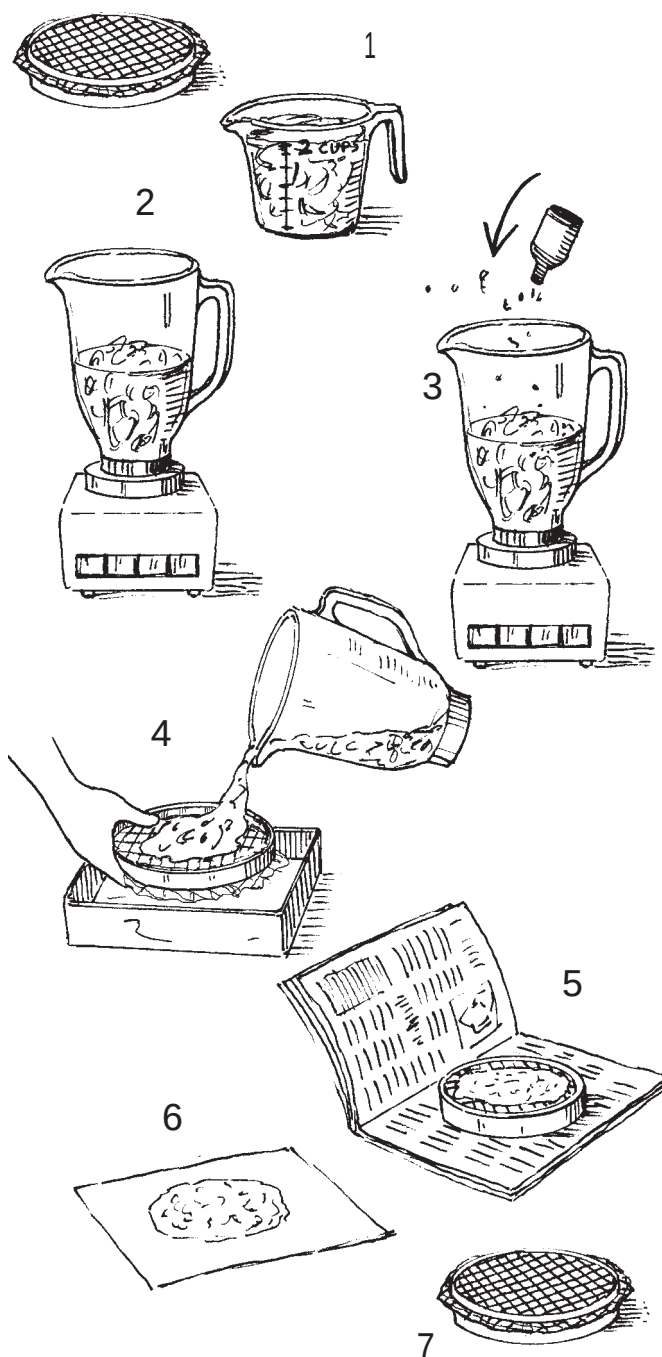
3 ADDITIVES: If your group has an additive put it into the blender or bowl at this time. Additives add color, texture and smell.

4 SHAPING: You will be pouring your paper pulp onto screens. Make sure to do this over the dishpans so they will catch the extra water. Pour enough pulp onto the inside of your hoop to cover the screening. Take the piece of plastic canvas and press onto the pulp to remove the excess water.

5 With the excess water removed from the pulp, place the hoop, with the canvas still in it, onto a section of newspaper. Use the newspaper to blot the extra moisture out of your recycled paper. You are ready to take out your paper when you blot and no water comes out.

6 Take out the plastic canvas and turn the hoop over onto a scrap piece of paper. Tap on the back of the screening. If the paper doesn't come out, take the hoop apart. Leave the recycled paper on the piece of scrap paper to dry.

7 Put the hoop back together to make your next sheet of paper.



NOTE: Collect leftover pulp in a strainer. DO NOT POUR PULP DOWN A SINK DRAIN - it might block it.

Student Handout

RECYCLED PAPER JEWELRY

MATERIALS

blender
2 cups shredded paper
warm water
2 tbs. Argo laundry powder starch

candy or cookie molds
dishpans
pin backs
jewelry glue

acrylic paint
matte spray finish
2 mesh screens or
metal strainers

1 Fill blender half full of warm water. Add 2 cups of shredded paper to warm water and 2 tablespoons of Argo laundry powder starch. Blend well. This mixture should be thick but still pourable.

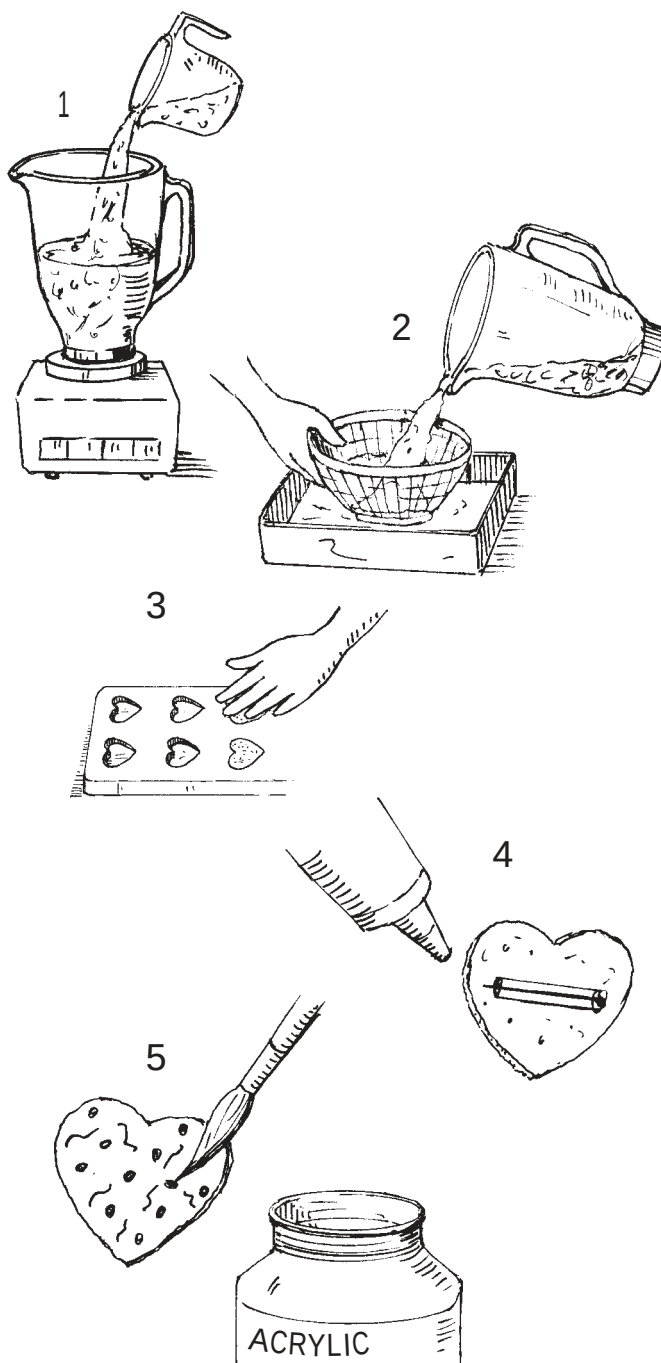
2 Pour mixture onto screen or into strainer over dishpan (to catch excess water). Take the other mesh screen and put it on top of the paper mixture and squeeze together to remove excess water. If using strainer, mix with hands until most of the water is out of the mixture.

3 Firmly press paper mixture into candy or cookie molds. Make sure the paper does not hang over the edge of the mold. Let molds dry for one to two days. The paper jewelry will easily come out of molds when completely dry.

4 When jewelry is dry, use glue to adhere pin back.

5 Paint your jewelry using an acrylic paint. After the paint has dried, spray your finished pin with a matte spray finish.

NOTE: Collect leftover pulp in a strainer. DO NOT POUR PULP DOWN A SINK DRAIN - it might block it.



Student Handout



PAPERMAKING COST-ANALYSIS SHEET

Name of company _____

Product produced

Students in company _____

SUPPLIES		NUMBER OF CHIPS	
		Money	Energy
Base Materials _____	Natural or Recycled Resource _____	_____	_____
Method _____		_____	_____
Additives _____		_____	_____
_____		_____	_____
_____		_____	_____
Framing _____		_____	_____
Drying Materials _____		_____	_____
Waste Management _____		_____	_____
Disposal _____		_____	_____
_____		_____	_____
Decorations _____		_____	_____
_____		_____	_____
_____		_____	_____
Labor _____		_____	_____
		_____	_____
How many paper products did you make? _____		Total money	Total energy
How many chips did each product cost to make? (total chips divided by number of products) _____		_____	
Were there any ways to make more pieces _____		Total chips (total money + total energy = total chips)	

Would you have saved or spent more if your product was made from recycled materials? _____

MATERIALS COST SHEET

	MONEY	ENERGY
BASE MATERIALS		
Newspaper (recycled)	.2	.2
Toilet paper (natural)	.3	.3
Scrap construction paper (recycled)	.2	.2
Tissue paper (natural)	.4	.3
Water	.1	.1
METHOD		
Blender	.4	.3
Whisk	.1	.3
ADDITIVES		
Colored tissue	.4	.3
Potpourri	.3	.2
Argo starch	.3	.3
String	.1	.1
Yarn	.1	.1
Feathers	.1	.1
FRAMING		
Screens	.3	.3
Molds	.3	.3

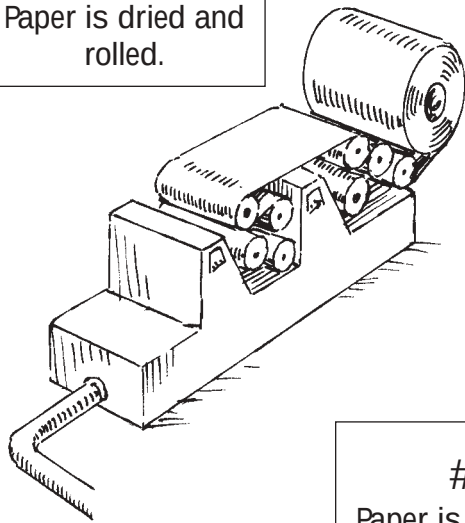
	MONEY	ENERGY
DRYING MATERIALS		
Newspaper	.2	.2
Scrap paper	.2	.2
WASTE MANAGEMENT		
Spills	.2	.2
DISPOSAL		
Waste newspaper	.2	.2
Waste water	.2	.4
Base paper	.5	.5
DECORATIONS		
Paint	.5	.3
Ribbon	.3	.3
Glitter	.3	.5
Glue	.3	.3
Doilies	.3	.3
LABOR		
One Worker	.2	.2

Student Handout

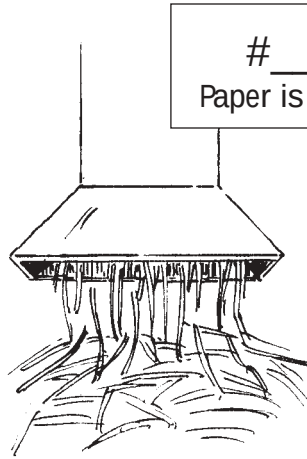
STEPS IN THE PAPERMAKING PROCESS

Directions: Put the papermaking process in the right order by numbering the pictures from 1 to 6.

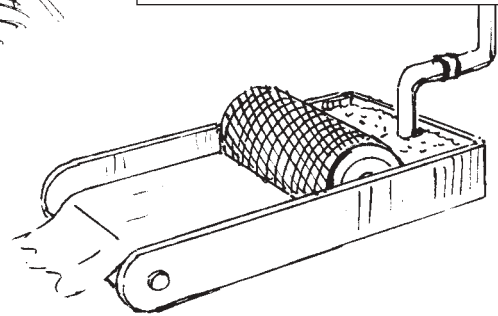
Paper is dried and rolled.



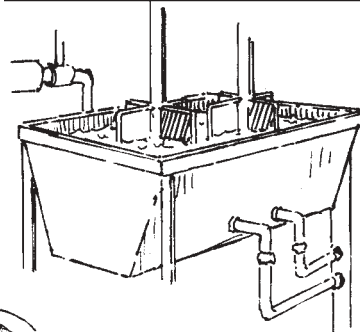
Paper is shredded.



Paper is poured onto a screen.



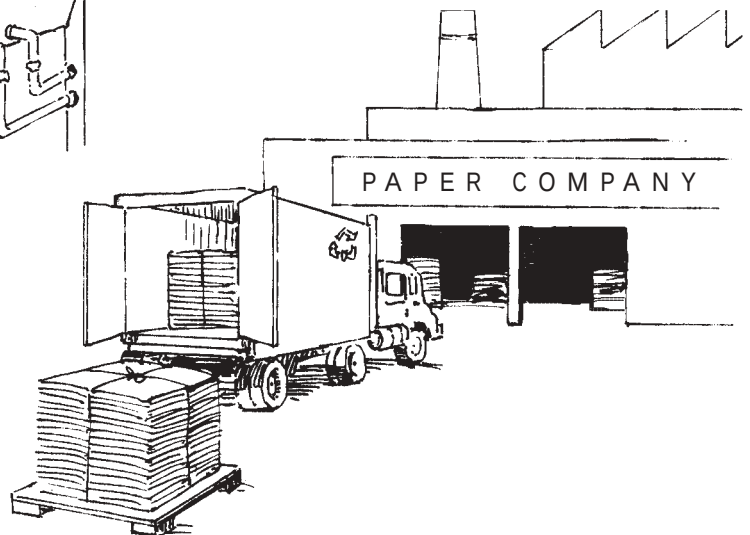
Paper is mixed with water in a digester/hydropulper.



Paper is made into new products.



Bales of paper enter mill.



THE PAPER FACTORY

Activity
2

What Sort of Trash is This Anyway?

Inquiries

- What can be recycled?
- What kinds of materials can be made into paper?

Content Domain

Science – General science

Learning Outcomes

Math, Grade 4, #24

Science, Grade 4, #1, #4

Duration

30 minutes

Materials

Five bags with five samples of each of the following: **newspaper, toilet paper, tissue, brown paper towel, construction paper, cardboard egg carton, plastic bag, film canister, plastic cup, can, metal or plastic toy, plastic soda pop bottle**

Handouts

- [Dichotomous Key](#)
- [Papermaking Terms Puzzle](#)

Objective

Students will be able to classify solid waste materials using a dichotomous key.

Preparation

Place a sample of each material into each of the five bags. Try to give each group the same materials and make sure there is a wide variety of materials to sort, some recyclable, some not (see categories on the handout, *Dichotomous Key*). Make a transparency of the handout, *Dichotomous Key*.

Procedure

- 1 Divide students into five groups. Give each group a bag of materials to sort and the handout, *Dichotomous Key*.
- 2 Explain that a dichotomous key is a tool to help in the sorting process and that they will see these kinds of keys on the proficiency test. Place the handout transparency on the overhead and explain to students how to sort.

NOTE: Through class discussion you may generate a list of items that can be recycled to help students with the activity. Or, lead a group discussion after the class completes the task and ask students to justify their answers.

- 3 Have each group place the key on a table, the floor or a group of desks. Then, using the classifications on the key, have students sort the materials in their bag. They should raise their hand any time they are asked to do so. When a group raises their hands, check what has been sorted so far. Ask questions about the students' sorting choices. If the students can justify their choices, they may move to the next sort.

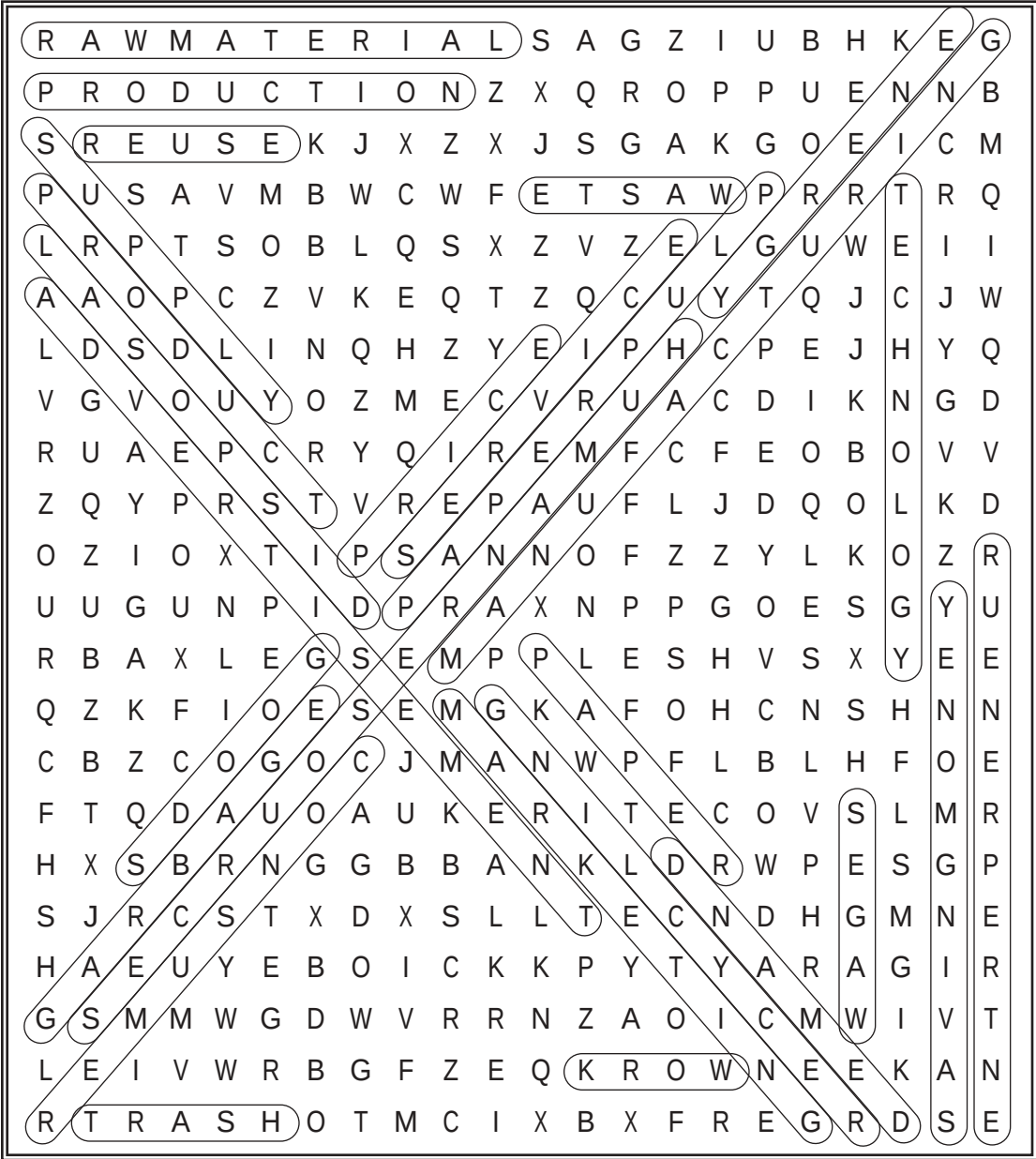
- 4 As a group, discuss the sorts each group made and share justifications.

- 5 After students are finished sorting, have them complete the handout, *Papermaking Terms Puzzle*.

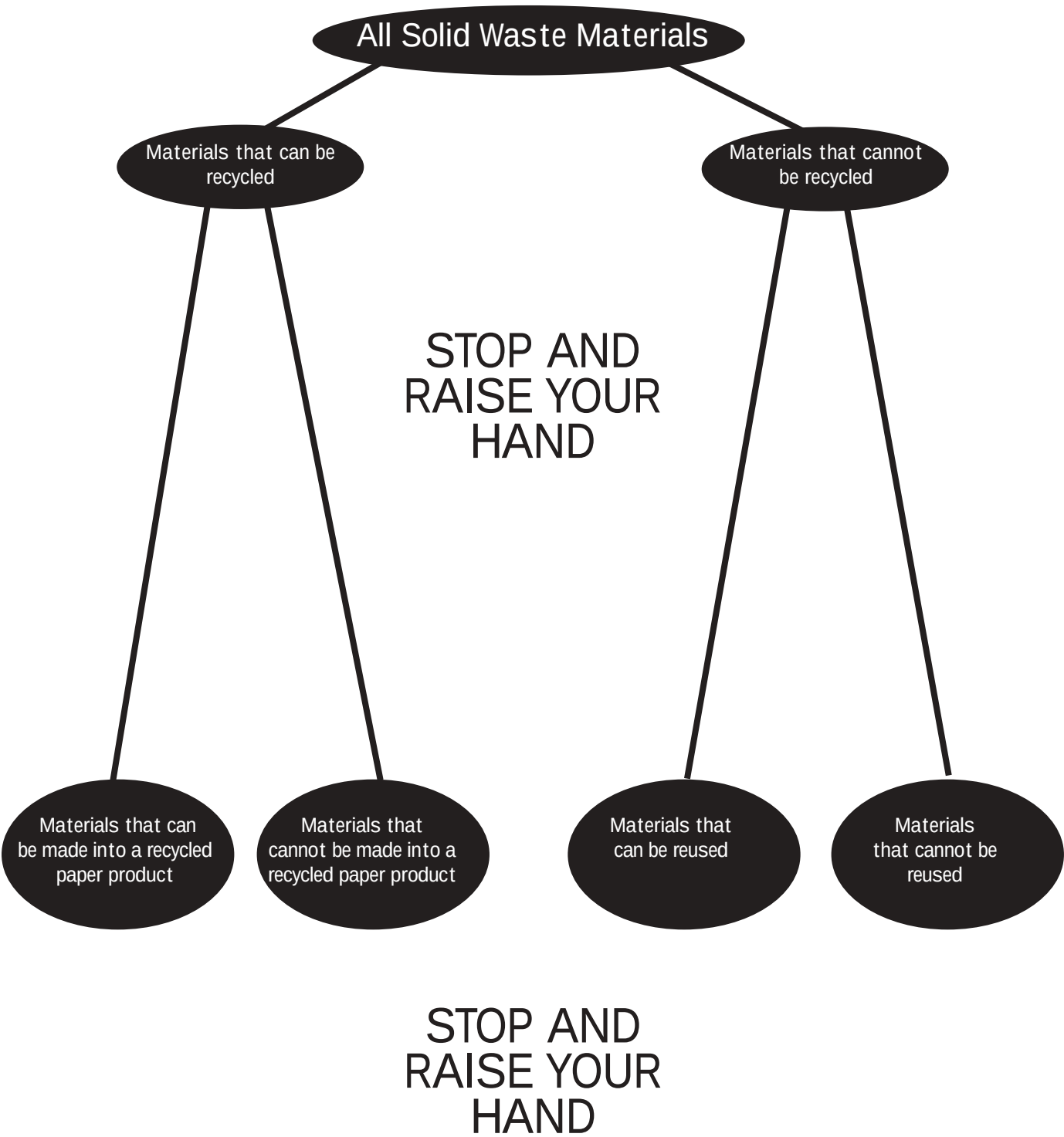
Assessment

Use the students' justification of sorts and class discussion to assess the activity.

Key to Papermaking Terms Puzzle, page 17



DICHOTOMOUS KEY



Student Handout



PAPERMAKING TERMS PUZZLE

Directions: Find the words listed below. They may appear diagonally, vertically, horizontally and/or backwards.



advertisement
consumer
demand
disposal
energy
entrepreneur

garbage
goods
human resources
manufacturing
marketing
paper

paper pulp
price
product
production
raw materials
recycling

reuse
saving money
service
supply
technology
trash

wages
waste
work

THE PAPER FACTORY

Activity
3**Inquiries**

- How does using recycled materials affect energy use, production costs and sale price?
- How does waste disposal affect costs and how can waste be reduced?

Content Domain

Math – Arithmetic (problem solving)

Science – General science, physical science

Social Studies – Economics

Learning Outcomes

Math, Grade 4, #4, #5, #8

Science, Grade 4, #1, #6

If extension is done, the following apply:

Citizenship, Grade 4, #10, #11 and Grade 6, #12

Duration

Part A: 60 minutes

Part B: 60 minutes

Part C: 60 minutes

Part D: 60 minutes

Part E: 35 minutes

Materials

Part A: See list of materials for Activity 1, *Papermaking*

Part C: tag board, markers, stencils, construction paper, glue

Part D: lunch bags, newspapers, ziplock bags, tissue paper, wrapping paper

continued next page

The Paper Company

Objectives

Students will be able to: (a) cooperate in groups to develop and implement plans; (b) compute with whole numbers to assess efficiency of the production process; and (c) discuss and write advertisements to market their products.

Preparation

Arrange to partner with another class for this activity. Students in the other class need to earn chips for their work so they can save for the “product sale.” It will take about two weeks to get ready for the sale, which includes drying time and days not working on this activity.

PART A: Students should create a journal to keep during the activity.

PART C: Cut examples of good advertising out of newspapers and magazines for students to use.

PART E: Schedule a time with the partner class when each production team can present and sell their product.

and sell them (for chips) to a younger class. (The partner class will be earning chips by working in their classroom.)

Student companies must meet three goals:

- Produce a paper product.
- Use the least amount of money, resources and energy possible.
- Make a decision about disposal of waste products. Disposal options include:
 - landfill
 - recycle
 - reuse
 - toxic waste landfill or incinerator
 - exchange it
 - litter or dump it

Procedure**PART A: Develop a Plan**

1 Review with students what they learned in Activity 1, *Papermaking*. Explain to students that they will be placed into groups to establish companies. Their companies will produce paper products, advertise the products

2 Students use the handout, *Creating Companies*, to make basic decisions about their companies. As part of their planning, students should complete the handout, *Papermaking Cost-Analysis Sheet #2*, by using the handout, *Materials Cost Sheet #2*, to estimate their costs. Students start with 100 chips to make their purchases. Their total cost needs to be less than the purchase price of materials. Remind students that they

should keep some money in reserve for unforeseen events.

3 Explain that each group will receive a limited number of resource and energy chips, so students should look at their estimated costs to make sure they can afford everything they want or decide where to make cost adjustments. To make a profit, the groups must receive more money (chips) for their product than they need to pay for their original expenditures. Also, they need to remember human resources (salary for their workers).

NOTE: The simulation works if you charge for everything or provide some items to each group at no cost.

4 Consider doing a sample for the class that shows how to figure cost, estimate the number of paper products produced and decide how much to charge for each product. Remind students that this is a plan and they may find that once they start production some things may need to change. You can also point out to students that if they look carefully at their materials cost sheet, they can save money in the area of waste product disposal.

PART B: Production

1 While two groups are in production, the other groups can work on Part C. The production process may take several days to complete to give each group an opportunity to make products.

2 Groups should refer back to the papermaking instructions in Activity 1, *Papermaking* (p. III-9), to make their product. Students need to purchase their materials. Remind them that they only have 100 chips to spend.

3 Students are now ready to produce their products. They must decide

how many products to produce and determine what to charge so they can pay costs and earn a profit.

4 Students also need to put into practice whatever decision they made about waste disposal. Charge for any waste materials according to the handout, *Materials Cost Sheet #2*.

PART C: Advertising

1 Discuss advertising, why companies advertise and what advertising says. Have students look at a variety of advertising from newspapers and magazines.

2 Each group that is not in production should work on their advertising. They can make posters and write jingles or scripts to advertise their product to the partner class. The group's advertising costs will come out of their original budget.

PART D: Decorate and Package

1 Allow students an opportunity to buy decorating and packaging materials. Discuss with students the importance of making a product attractive to buyers.

2 Students decorate and package their products for sale. Ask students to avoid excess packaging and use packaging to protect the product. Students should also use packaging to promote the product and company name.

PART E: Product Show and Sale

1 Groups are now ready to sell their products. They can hang their posters, perform any commercial they have and then place their products on a sales table. All products will remain on the sales table until presentations are made. The partner class will then have an opportunity to buy the products.

THE PAPER FACTORY

Handouts

- *Creating Companies*
- *Papermaking Cost-Analysis Sheet #2*
- *Materials Cost Sheet #2*
- *Final Financial Statement*

2 After the sale, have students figure finances by completing the handout, *Final Financial Statement*. Have them complete their final journal entry.

3 Discuss group findings – what would they do the same and what would they do differently?

At the end of each part in this activity, students should make an entry in a journal noting what they learned about companies and how companies work.

Assessment

Assessment can be made using a rubric designed by companies, reviewing journal entries, or by evaluating participation in discussion and accuracy of written work.

Extension

Review the information provided in the lesson, *Garbage Goods*, p. II-5. Depending upon students' prior knowledge about the factors of production, review some of the handout information (such as the handout, *Factors of Production*, on p. II-21). Have students reconsider all of the materials and processes that were required to make their product and classify them according to the factors of production. Also, suggest alternative uses for various resources.

Student Handout

CREATING COMPANIES

1 Choose your company name. _____

2 Choose the paper product to make for the sale. _____

3 Using the handout, Papermaking Cost Analysis #2, determine which materials you will need for your paper product and how much they will cost (see the handout, Materials Cost Sheet #2).

Write an estimate of total costs here. _____

	Money	Energy
Landfill (See disposal on Cost Analysis)		
Recycle	1	1
Reuse	0	1
Toxic landfill	5	5
Exchange	0	0
Litter or dump it	8	8

4 Decide how to handle your waste products:

Determine costs and add to total in #3 _____

5 Decide how many products you will need to make and how much you will have to charge in order to make a profit. _____

Student Handout



PAPERMAKING COST-ANALYSIS SHEET #2

Name of company _____

Product produced _____

Students in company _____

SUPPLIES	NUMBER OF CHIPS	
	Money	Energy
Base Materials _____ Natural or Recycled Resource	_____	_____
Method _____	_____	_____
Additives _____	_____	_____
_____	_____	_____
_____	_____	_____
Framing _____	_____	_____
Drying Materials _____	_____	_____
Waste Management _____	_____	_____
Disposal _____	_____	_____
_____	_____	_____
Decorations _____	_____	_____
_____	_____	_____
_____	_____	_____
Labor _____	_____	_____
Advertising Materials _____	_____	_____
_____	_____	_____
Packaging Materials _____	_____	_____
_____	_____	_____
Add up your money chips and energy chips.	_____	_____
	Total money	Total energy
Mark the total number of chips for materials and labor on your handout, Creating Companies.	_____	
	Total chips	
	(total money + total energy = total chips)	

Student Handout



MATERIALS COST SHEET #2

MONEY ENERGY

BASE MATERIALS

Newspaper (recycled)	.2	.2
Toilet paper (natural)	.3	.3
Scrap construction paper (recycled)	.2	.2
Tissue paper (natural)	.4	.3
Water	.1	.1

METHOD

Blender	.4	.3
Whisk	.1	.3

ADDITIVES

Colored tissue	.4	.3
Potpourri	.3	.2
Argo starch	.3	.3
String	.1	.1
Yarn	.1	.1
Feathers	.1	.1

FRAMING

Screens	.3	.3
Molds	.3	.3

DRYING MATERIALS

Newspaper	.2	.2
Scrap paper	.2	.2

WASTE MANAGEMENT

Spills	.2	.2

MONEY ENERGY

DISPOSAL

Waste newspaper	.2	.2
Waste water	.2	.4
Base paper	.5	.5

DECORATIONS

Paint	.5	.3
Ribbon	.3	.3
Glitter	.3	.5
Glue	.3	.3
Doilies	.3	.3

LABOR

One Worker	.2	.2

ADVERTISING MATERIALS

Tag board	.3	.3
Markers	.2	.2
Stencils	.1	.1
Glue	.2	.2
Construction paper	.3	.3

PACKAGING MATERIALS

Lunch bags	.3	.3
Newspapers	.2	.2
Plastic bags	.3	.3
Wrapping paper	.4	.3

Student Handout



FINAL FINANCIAL STATEMENT

Name of company _____

Members of company _____

Total cost of product (including human resources) \$ _____

Total income from sales \$ _____

Profit \$ _____

Loss \$ _____

What would you do differently if you could begin again? _____

What did you do well? _____

What did you learn from this lesson? _____

THIS IS YOUR LIFECYCLE!

Environmental Studies Learning Concept

A *lifecycle analysis (LCA) can help determine the environmental impacts of our consumer culture, in terms of specific products. These impacts include those associated with land use, energy and resource use, and pollution. LCA models are based on the materials management system in society – how we use resources to make materials – from a cradle-to-grave perspective. LCA can help make decisions about which products to produce and how to produce them. LCA complements, but sometimes conflicts with, market forces of consumer demand and material supplies.*

Recycling proves to be beneficial for several reasons when modeled using LCA. The benefits of recycling can include energy and resource conservation and pollution reduction depending upon the product lifecycle analysis. Also, recycling reduces the need to use land space for disposal.

Vocabulary

bale – to compress, bind or wrap

bauxite – a clay-like ore; used to make aluminum

coal – a mineral resulting from the partial decomposition of vegetable matter, lack of oxygen and under varying degrees of increased temperature and pressure over a period of millions of years; used to make steel

cullet – small pieces of glass

cycle – a course of events or operations that recur regularly and usually lead back to a starting point

energy input – the work required to turn a natural resource into a product

iron ore – a mineral from which metals can be extracted; used to make steel

landfill – a place where solid waste is buried, compacted and covered with soil

lifecycle analysis – a method of accounting for all the environmental impacts resulting from a single product

limestone – a rock consisting mainly of calcium carbonate; used to make steel and glass

manufacture – the process of turning raw materials into finished products, usually with the aid of machines

mold – a hollow form designed to give a specific shape to something in a molten state

molten – melted

natural resource – material extracted from nature, not made by humans

output – the product, good or material that results from the manufacturing process

petroleum – a natural, thick, oily, flammable, dark liquid mixture found beneath the Earth's surface; used to make such products as natural gas, gasoline and plastics

pollution – the contamination of soil, water or air by the discharge or improper disposal of harmful substances

process – a particular method of doing something, generally involving a number of steps

pulp – a mixture of cellulose material, such as wood, paper and rags, ground up and moistened to make paper

raw materials – natural resources, processed materials or recycled materials used in manufacturing processes

recycled materials – materials from the solid waste stream that are used instead of/in combination with raw materials in the manufacturing process

resins – organic substances from various plants and trees; resins can also be manufactured synthetically like the resins used to make plastics

soda ash – crude sodium carbonate; used in the formation of glass

solid waste – regularly collected waste from households, institutions and commercial establishments

transportation energy – the work required to move something from one place to another

wood chips – small pieces of wood; used as raw material in the papermaking process

Overview - THIS IS YOUR LIFECYCLE!



1

Activity 1: Lifecycle Bingo

Description

Students participate in a modified bingo game to *identify* the symbols and the mathematical attributes of the symbols used to represent the parts of a product lifecycle. Students *use a key* to match words and definitions with the symbols that represent them. They *infer* from text the words and phrases that describe various parts of the lifecycle of a glass bottle.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #1 – Sort or identify objects on multiple attributes.

Grade 4, Reading #4 – Identify and interpret vocabulary critical to the meaning of the text.

Grade 4, Reading #17 – Infer from the text.

Grade 4, Science #4 – Use a simple key to distinguish between objects, organisms and/or phenomena.

Grade 6, Reading #12 – Infer from the text.

Summary

This lesson has two activities, which should be conducted in the order they are presented. The first activity introduces students to the symbols needed to construct a lifecycle model. The second activity engages students in the construction of lifecycle models.

Activity 2: Lifecycle Hopscotch

Description

With the teacher's help, students construct a classroom-size product lifecycle model by using paper cutouts for each step of the lifecycle. Students *make inferences* from descriptions of the steps in the product lifecycle to sequentially order the steps onto a classroom model. Students then role-play various environmental impacts – energy, natural resources, pollution. Lifecycle Hopscotch is played twice, first using a process that uses only natural resources, and again with a process that replaces natural resources with recycled materials. Students graph environmental data and compare the environmental impact of making the product with natural resources to making it using recycled materials.

Students also *cooperate in groups* and *manipulate materials* to construct one of four additional product lifecycles. Students *organize and graph data* for the product and compare using natural resources to using recycled materials. They construct graphs again to *compare and analyze* the data from all five product lifecycles.

2

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #11 – Name the resources needed to produce various goods and services.

Grade 4, Mathematics #24 – Make or use a table to record and sort information (in a problem-solving setting using simple and complex patterns in nature, art or poetry as setting) and make identifications, comparisons and predictions from tables, picture graphs, bar graphs and labeled picture maps.

Grade 4, Reading #2 – Use graphic aids (for example, a table or graph) or illustrations to locate or interpret information.

Grade 4, Science #5 – Analyze a series of events and/or simple daily or seasonal cycles and predict the next likely occurrence in the sequence.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Mathematics #21 – Collect data, create a table, picture graph, bar graph, circle graph or line graph and use them to solve application problems.

Background Information

Natural resources are used everyday to **manufacture** new products. These resources are often used as **raw materials** in the **manufacturing process**. The manufacturing process requires **energy inputs** (transportation and mechanical) to turn a natural resource into a product, or **output**. **Pollution emissions** and **solid waste** often result from these types of **processes**.

Buying and using products that result in less waste is one aspect of source reduction or waste prevention. Mapping the manufacturing process or doing a **lifecycle** analysis of a product can show us how much energy and natural resources are required and how much pollution and waste is generated when making the product. Lifecycle analysis (LCA) traces the “life” of a product from cradle to grave – from the beginning when natural resources are extracted and used

in the manufacturing process to the final disposal of the product. In addition, lifecycle analysis charts the flow of energy and natural resources in an artificial ecosystem (manufacturing) and identifies the costs of doing business in an industrial economy.

Most lifecycles have six steps:

- acquiring natural resources
- manufacturing
- distribution and transportation
- use and reuse
- recycling
- disposal

Each step requires different types of natural resources and energy inputs, and creates outputs of pollution and waste. Overall, these stages may have a significant impact upon the environment.

Technology has created increasing demands for the Earth’s energy and natural resources. Using technology to manufacture products that meet our needs and wants has also generated

pollution. Mapping the lifecycle of a product offers an effective way to analyze the environmental impacts associated with energy and natural resource use, pollution emissions and solid waste disposal and recycling. In fact, most LCA studies indicate that recycling is beneficial for many reasons, depending upon the specific product.

Lifecycle analysis studies are not usually well developed enough to make specific comparisons between similar products such as, which is more harmful to the environment, a paper cup or plastic cup. However, LCAs can help identify the trade-offs associated with different choices. The information enables industry and business to identify where and when to use practices that conserve energy and resources, and reduce environmental emissions and solid waste.

Bibliography and Additional Resources

Student Resources

The Great Glass Caper, The Glass Container Industry, 1990.

Educator Information

Lifecycle Analysis, An Ounce of Prevention, National Science Teachers Association, 1997.

Paper or Plastic? A Lifecycle Analysis Perspective, An Ounce of Prevention, National Science Teachers Association, 1997.

Scrap Map Teacher's Kit, Institute of Scrap Recycling Industries, Inc., 1990.

"Product Lifecycles and Recycling," *Investigating Solid Waste Issues*, Ohio Department of Natural Resources, 1996.

Activity 1

Lifecycle Bingo

Objectives

Students will be able to: (a) identify symbols that represent the parts of a manufacturing lifecycle; (b) use a key to match words and definitions with the symbols that represent them; and (c) identify and interpret vocabulary used to describe the manufacturing lifecycles for aluminum, glass, paper, plastic and steel.

Preparation

Cut out the individual *Lifecycle Cards* that start on p. IV-14 and glue each description on a 3"x 5" card. The key for the cards is on p. IV-13, *Lifecycle Description Key*.

Procedure

- 1 Give each student a bingo card, as well as enough buttons to play several games. Make sure the five different bingo cards are distributed equally among the class.
- 2 Using a transparency of the handout, *Lifecycle Symbol Key*, introduce students to the five symbols and

THIS IS YOUR LIFECYCLE!

Inquiries

- How can geometric shapes be used to make a model of a product lifecycle?
- What environmental and production factors are important in the making of a product?

Content Domain

Math

Reading – Comprehension

Science – General science

Learning Outcomes

Math, Grade 4, #1

Reading, Grade 4, #4, #17 and Grade 6, #12

Science, Grade 4, #4

Duration

45-50 minutes

continued next page

THIS IS YOUR LIFECYCLE!

Materials

Buttons, 52-3"x 5" cards, copies of each of the five different **bingo cards, transparency** of *Lifecycle Symbol Key*

Handouts

- *Lifecycle Symbol Key*
- *Lifecycle Bingo Cards 1-5*
- *Lifecycle Description Key*
- *Lifecycle Cards*
- *Matching Symbols and Definitions*
- *Making Glass from Raw Materials*

explain what they represent. Be sure to explain the attributes of each symbol (e.g., the number of sides of each symbol) and what the symbol (shape) is called (hexagon, square, etc.). Ask students to give examples of each symbol. (When giving examples of natural resources—the trapezoid—you can note that Ohio's natural resources include trees, coal, water, sand and limestone.)

3 Play a few games of Lifecycle Bingo by calling letters and one of the five symbols used to construct a manufacturing lifecycle. For example, when the instructor calls "B process," students would place a button on a **square** under column **B**. When the instructor calls "N output," students would place a button on a **hexagon** under column **N**. The instructor may want to mark his/her own bingo card on the overhead as he/she calls the letters and symbols.

4 Students who have five buttons placed in a vertical, horizontal or diagonal line on their bingo card win the game. Ask winners to yell "recycle" instead of "bingo" when they fill a line.

5 A more challenging way to play Lifecycle Bingo is to use the *Lifecycle Cards* instead of calling letters and symbols. After listening to a description of what the symbol represents, students must decide whether the description is a process, energy input, transportation energy, an output or a natural resource and mark their card appropriately. For example, when the instructor says "glass jar," students would place a button on a **hexagon** because glass jar represents an output. If the instructor reads "coal is carried on a barge to a coal-burning power plant," students would place a button on a **diamond** because coal carried on a barge describes transportation energy.

Be sure to check the winners' answers to make sure he/she has chosen the correct symbol for each description. In cases where the correct answer could be either a process or transportation energy, the instructor should ask students which is the best answer.

NOTE: Descriptions depicting transportation energy will have a word in them directly related to transportation – "carried," "shipped," "trucked."

Assessment

The handout, *Matching Symbols and Definitions*, assesses students' understanding of the symbols that are used to make a product lifecycle model in the next activity. The handout, *Making Glass from Raw Materials*, assesses students' understanding of the elements that are required to make a product and the use of symbols to represent them.

ANSWERS to *Matching Symbols and Definitions*:

1. trapezoid=natural resources
2. diamond=transportation energy
3. hexagon=output
4. triangle=energy output
5. square=process
6. square, trapezoid, diamond
7. hexagon
8. triangle

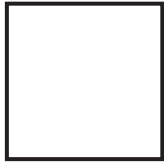
ANSWERS to *Making Glass from Raw Materials*:

1. the lime, soda ash and sand are mixed together...square
2. lime, soda ash and sand...trapezoid
3. gasoline or diesel fuel powers...triangle
4. a finished glass container...hexagon
5. three natural resources are then transported...diamond

Student Handout



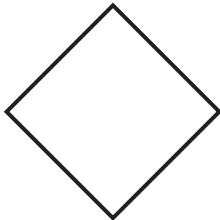
LIFECYCLE SYMBOL KEY



SQUARE

PROCESS

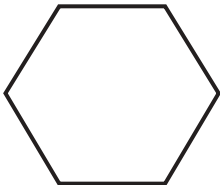
A particular method of doing something, generally involving a number of steps



DIAMOND

TRANSPORTATION ENERGY

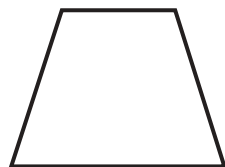
The work required to move something from one place to another



HEXAGON

OUTPUT

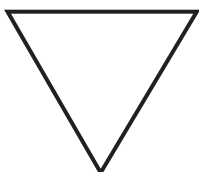
The product, good or material that results from the manufacturing process



TRAPEZOID

NATURAL RESOURCE

Material extracted from nature, not made by humans

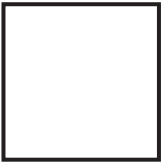
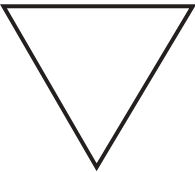
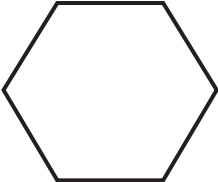
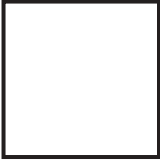
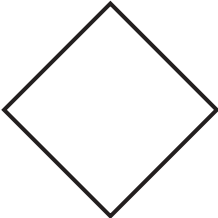
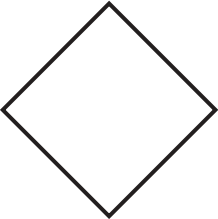
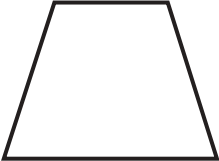
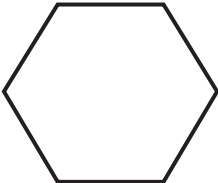
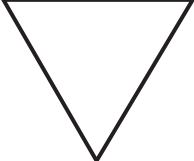
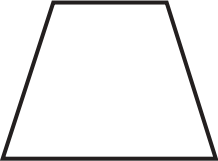
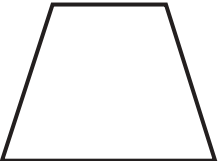
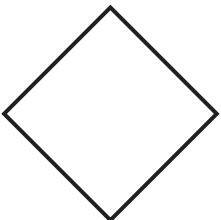
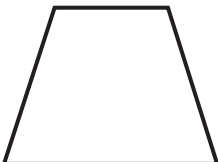
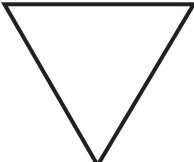
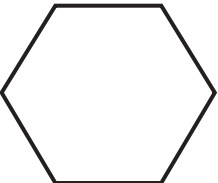
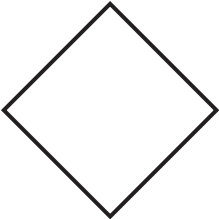
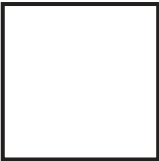
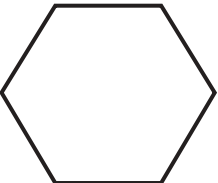
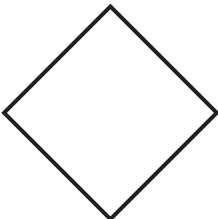
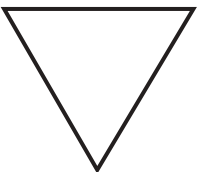
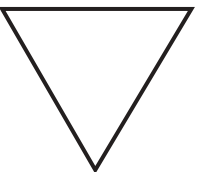
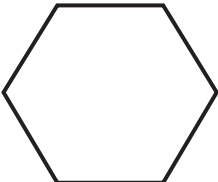
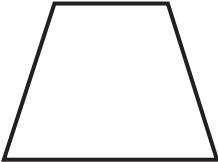
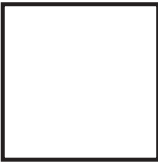


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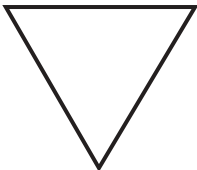
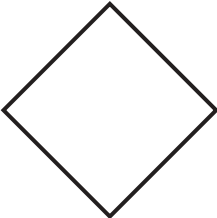
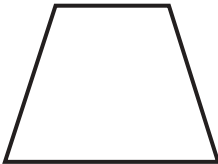
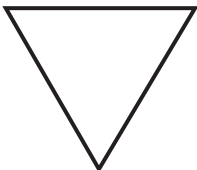
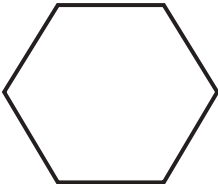
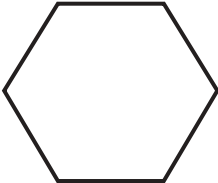
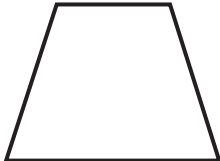
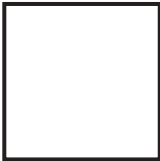
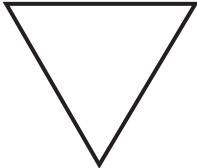
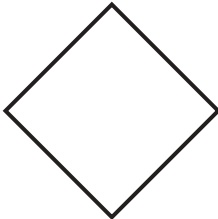
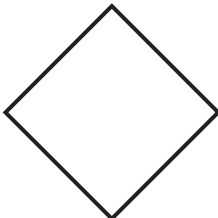
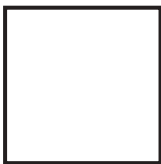
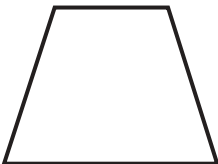
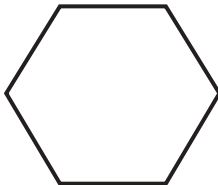
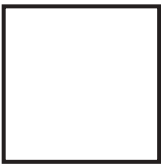
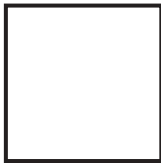
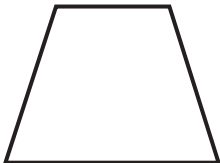
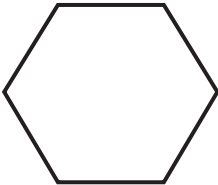
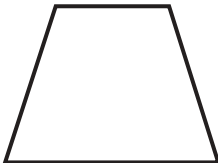
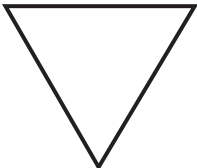
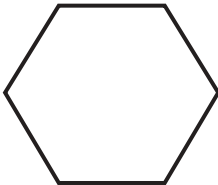
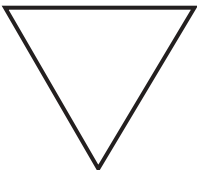
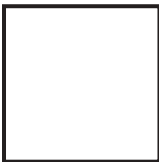
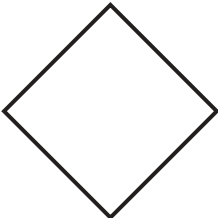
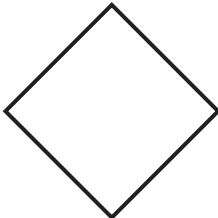
ENERGY INPUT

The work required to turn a natural resource into a product

LIFECYCLE BINGO CARD #1

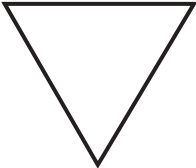
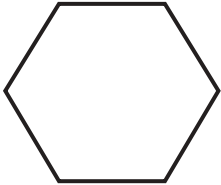
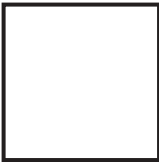
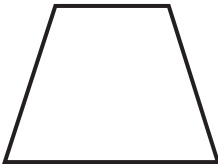
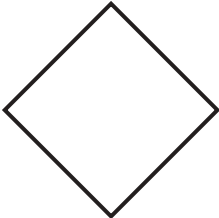
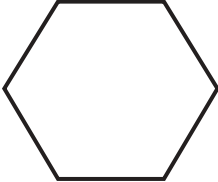
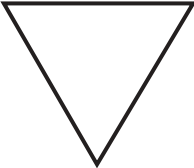
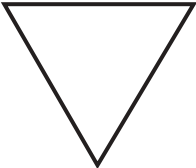
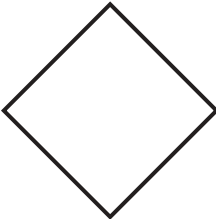
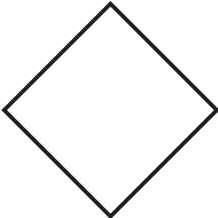
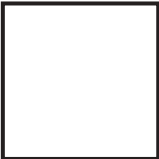
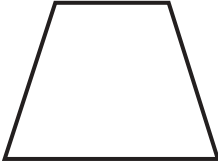
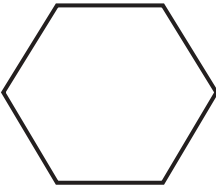
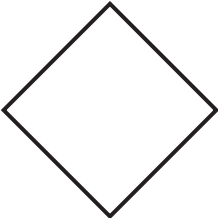
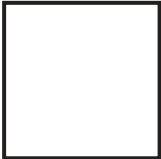
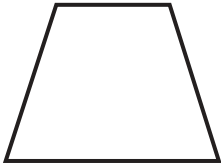
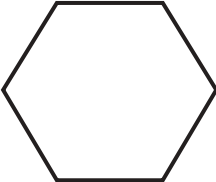
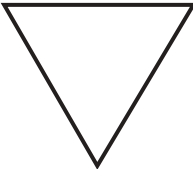
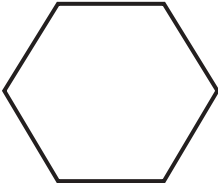
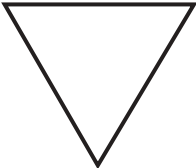
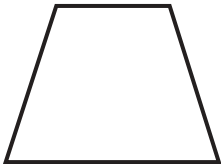
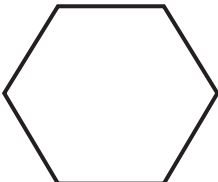
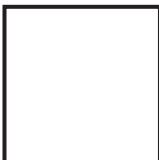
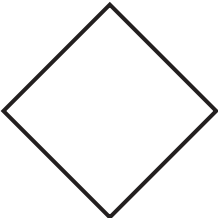
B	I	N	G	O
				
				
				
				
				

LIFECYCLE BINGO CARD #2

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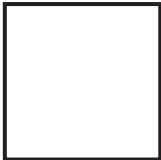
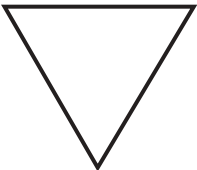
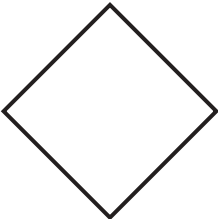
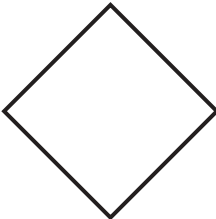
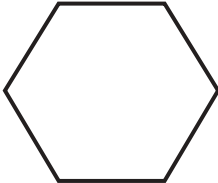
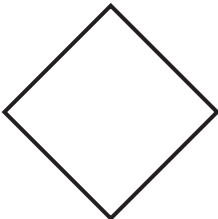
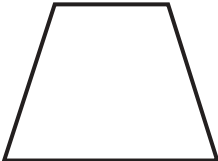
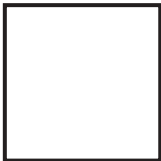
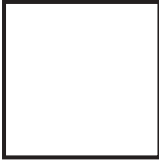
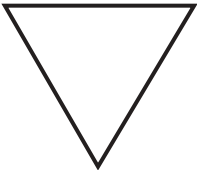
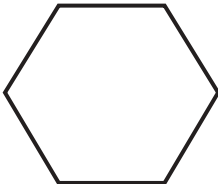
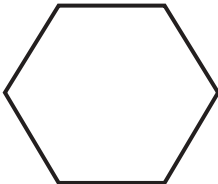
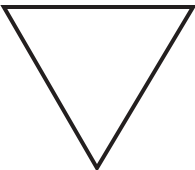
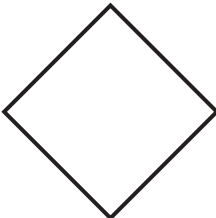
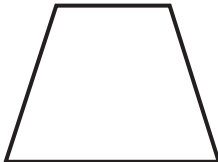
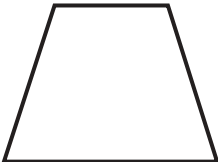
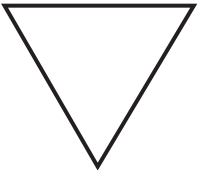
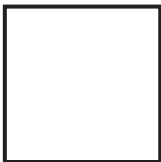
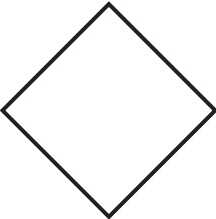
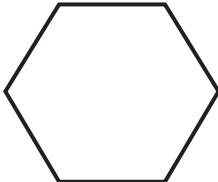
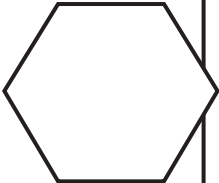
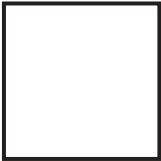
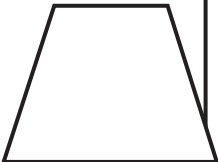
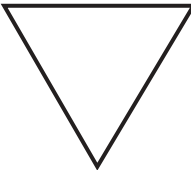
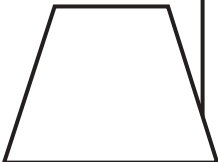
Student Handout

LIFECYCLE BINGO CARD #3

B	I	N	G	O
				
				
				
				
				

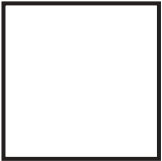
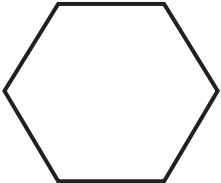
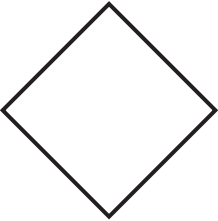
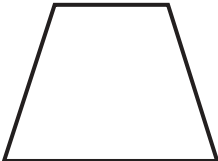
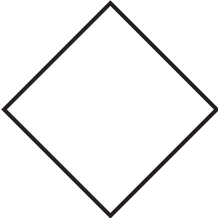
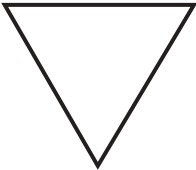
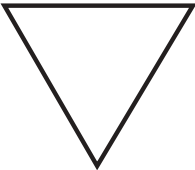
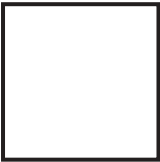
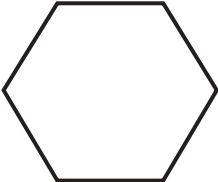
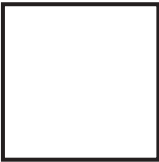
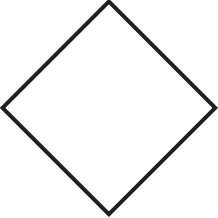
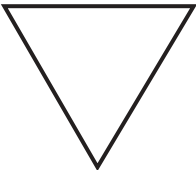
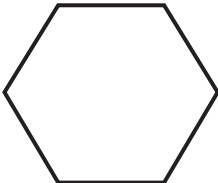
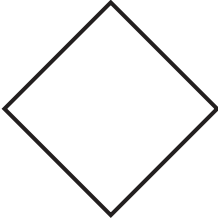
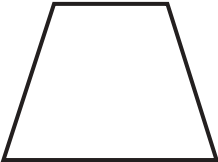
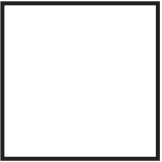
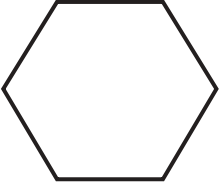
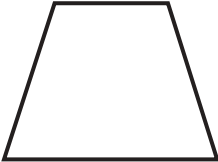
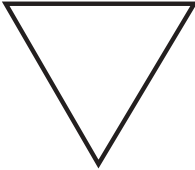
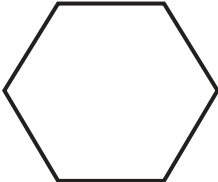
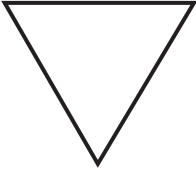
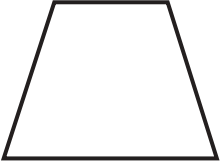
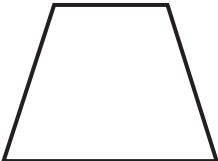
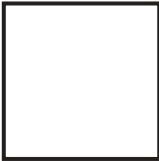
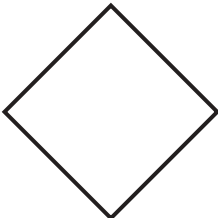
Student Handout

LIFECYCLE BINGO CARD #4

B	I	N	G	O
				
				
				
				
				

Student Handout

LIFECYCLE BINGO CARD #5

B	I	N	G	O
				
				
				
				
				

LIFECYCLE DESCRIPTION KEY

(Individual descriptions printed on the following pages (Lifecycle Cards) can be cut out or copied onto 3" x 5" cards for student or instructor use.)

Transportation Energy

- coal is carried on a barge to a coal-burning power plant
- glass cullet is shipped to a glass container manufacturer
- solid waste is trucked to a sanitary landfill
- recycled materials are delivered to a recycling center
- recycled glass containers are delivered by train to a glass processing plant
- harvested trees are trucked to a paper mill
- sheets of aluminum are sent to a can manufacturing plant
- paper is delivered to a store

Output

- glass jar
- plastic lumber park bench
- plastic milk jug
- refrigerator
- aluminum can
- cardboard box
- aluminum foil
- writing paper
- newspaper
- aluminum siding
- steel food can
- washing machine

Natural Resource

- air
- trees
- iron ore
- animals
- coal
- land
- sand
- oil
- natural gas
- limestone
- water
- bauxite

Process

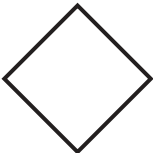
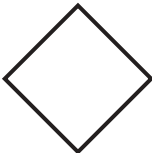
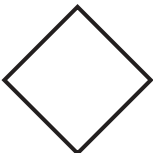
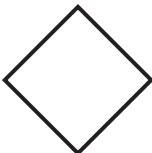
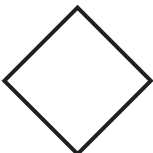
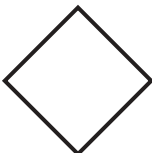
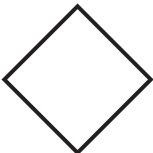
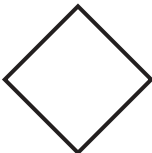
(NOTE: All processes require energy input and produce pollution)

- harvested trees are cut into wood chips
- recycled aluminum cans are melted
- large rolls of paper are cut into sheets
- recyclables and garbage are collected
- recycled aluminum cans are baled
- recycled glass is mixed with sand, soda ash and limestone in a furnace
- iron ore, coal and limestone are melted in a furnace
- recycled cardboard is mixed with water, old newsprint and other papers
- recycled paper is baled
- melted aluminum is molded into new aluminum cans
- recycled glass containers are sorted by color and crushed into small pieces
- iron ore is crushed into pellets and put in a furnace

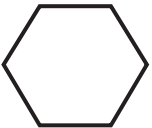
Energy Input

- fuel used when harvested trees are trucked to a paper mill
- electricity used to cut large rolls of paper into sheets
- electricity used to put recycled paper in bales
- electricity used to mix water, old newsprint and other waste papers
- electricity used to melt recycled aluminum cans
- fuel used when glass containers are shipped to a recycling center
- fuel used to heat a furnace
- work required when humans collect and separate recyclables

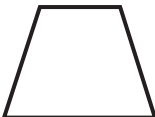
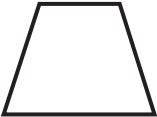
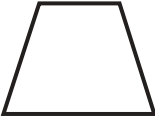
Lifecycle Cards (1 of 7)

 coal is carried on a barge to a coal-burning power plant	 glass cullet is shipped to a glass container manufacturer
 solid waste is trucked to a sanitary landfill	 recycled materials are delivered to a recycling center
 recycled glass containers are delivered by train to a glass processing plant	 harvested trees are trucked to a paper mill
 sheets of aluminum are sent to a can manufacturing plant	 paper is delivered to a store

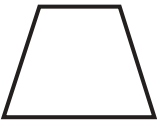
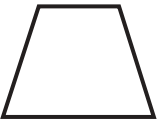
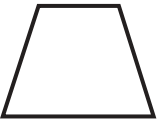
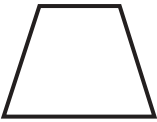
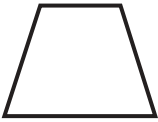
Lifecycle Cards (2 of 7)

 glass jar	 plastic lumber park bench
 plastic milk jug	 refrigerator
 aluminum can	 cardboard box
 aluminum foil	 writing paper

Lifecycle Cards (3 of 7)

 newspaper	 aluminum siding
 steel food can	 washing machine
 air	 trees
 iron ore	 animals

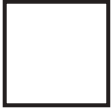
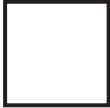
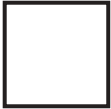
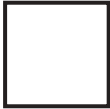
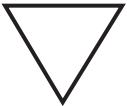
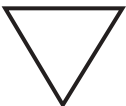
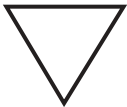
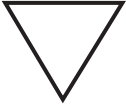
Lifecycle Cards (4 of 7)

 coal	 land
 sand	 oil
 natural gas	 limestone
 water	 bauxite

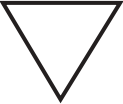
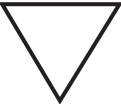
Lifecycle Cards (5 of 7)

harvested trees are cut into wood chips	recycled aluminum cans are melted
large rolls of paper are cut into sheets	recyclables and garbage are collected
recycled aluminum cans are baled	recycled glass is mixed with sand, soda ash and limestone in a furnace
iron ore, coal and limestone are melted in a furnace	recycled cardboard is mixed with water, old newsprint and other papers

Lifecycle Cards (6 of 7)

 recycled paper is baled	 melted aluminum is molded into new aluminum cans
 recycled glass containers are sorted by color and crushed into small pieces	 iron ore is crushed into pellets and put in a furnace
 fuel used when harvested trees are trucked to a paper mill	 electricity used to cut large rolls of paper into sheets
 electricity used to put recycled paper in bales	 electricity used to mix water, old newsprint and other waste papers

Lifecycle Cards (7 of 7)

 electricity used to melt recycled aluminum cans	 fuel used when glass containers are shipped to a recycling center
 fuel used to heat a furnace	 work required when humans collect and separate recyclables

Student Handout



MATCHING SYMBOLS AND DEFINITIONS

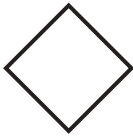
Directions: Draw a line from the word on the right to the symbol on the left that represents it.

1.



PROCESS

2.



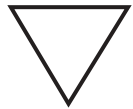
ENERGY INPUT

3.



NATURAL RESOURCE

4.



TRANSPORTATION ENERGY

5.



OUTPUT

6. What are the names of the symbols with four sides?

7. What is the name of the symbol with six sides?

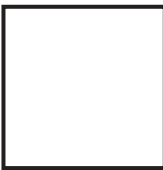
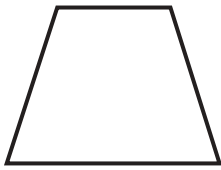
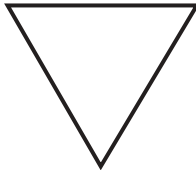
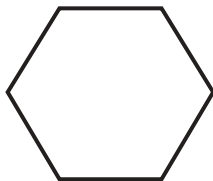
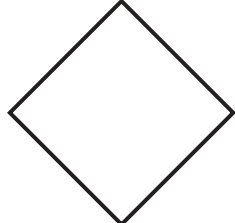
8. What is the name of the symbol with three sides?

Student Handout

MAKING GLASS FROM RAW MATERIALS

Directions: Read the following paragraph and in the space beside each symbol, write the words or phrases from the paragraph that match the symbols that represent different steps in the manufacturing process.

Lime, soda ash and sand are removed from the earth. Gasoline or diesel fuel powers the machines that remove the lime, soda ash and sand from the earth. These three natural resources are then transported to a glass manufacturing plant. At the plant, the lime, soda ash and sand are mixed together and heated at a very high temperature to make a glassy liquid. This liquid is then dropped into a mold where it is formed into a finished glass container. Before the container is ready to be shipped to a store or food processing facility, the container is reheated and allowed to cool slowly.

SYMBOL		PHRASES OR WORDS THAT MATCH THE SYMBOL	
1.			
2.			
3.			
4.			
5.			



Lifecycle Hopscotch

Objectives

Students will be able to: (a) identify when energy is required, natural resources are consumed and pollution is emitted in a product lifecycle; (b) explain the environmental impact of using recycled materials in a product lifecycle; and (c) construct bar charts to illustrate and compare the environmental impacts of using natural resources and recycled materials in a product lifecycle.

Preparation

Review the teacher pages. Begin with the teacher page, *Product Lifecycle Model*. This model can be used for each of the five products (*aluminum cans, glass bottles, newspaper, plastic bottles and steel cans*) explained on additional teacher pages.

There are two teacher pages for each of the five products. Each pair includes: an explanation of the lifecycle model and the environmental impacts when the product is made from natural resources (*Making Aluminum Cans, Glass Bottles, Newspaper, Plastic Bottles and Steel Cans from Natural Resources*) **and** an explanation of the lifecycle model and the environmental impacts when the product is made using recycled materials (*Making Aluminum Cans, Glass Bottles, Newspaper, Plastic Bottles and Steel Cans from Recycled Materials*).

Decide which product lifecycle to use in the activity. You will need two copies of each pair of teacher pages; one to be cut up into the various parts, the other to be used to conduct the “hopscotching.”

NOTE: Remember, the numbers for the various steps (symbols) on the teacher

page, *Product Lifecycle Model*, correspond with the numbers on each of the pairs of product explanations.

Make the steps for a large classroom model of the *Product Lifecycle Model*. Using large (8½" x 11" or larger) sheets of paper, cut each in the appropriate shape as indicated on the *Product Lifecycle Model*. (The shapes are the same geometric symbols used in the first activity and they represent the same steps of a lifecycle as previously discussed.) Be sure to add energy inputs (triangles) to processes (squares). To designate pollution emissions, add a “P” to transportation energy (diamonds) and to processes (squares). Also, include enough arrows to indicate the flow of the lifecycle.

Cut out the descriptions – **not including the numbers for energy inputs, pollution, resources, etc, in parenthesis** – of each step of the product’s lifecycle. These will be applied in discussion with students after the lifecycle symbols have been placed sequentially on the floor or wall.

A floor or wall space of approximately 20 feet by 5 feet will be required to assemble the lifecycle of your choice.

THIS IS YOUR LIFECYCLE!

Inquiries

- How is a product made when only using natural resources?
- How is a product made when using recycled materials?
- In a product lifecycle, when does using recycled materials reduce the amount of energy required, the amount of natural resources consumed and the amount of pollution emitted?

Content Domain

Math – Arithmetic

Science – General science

Social Studies – Economics

Learning Outcomes

Citizenship, Grade 4, #11

Math, Grade 4, #24 and Grade 6, #21

Reading, Grade 4, #2

Science, Grade 4, #5, #14

Duration

Part A: 45-50 minutes

Part B: Two 50-minute periods

Materials

Part A: 8½" x 11" (or larger) **cards** with individual steps for ONE of the lifecycles (*aluminum, glass, paper, plastic or steel*), **three groups of items, each a different color, 20 items in each group (20 gray fuzzies, 20 green, 20 red)** that can be passed from one student to another in their hands.

continued next page

THIS IS YOUR LIFECYCLE!

Materials, Part B: three sets of color-coded items (fuzzies), 80 each color for four student groups. If more groups are used, additional fuzzies are needed.

Handouts

- *Product Lifecycle Model*
 - *Environmental Impacts and the Product Lifecycle Models*
 - *Making _____ from Natural Resources: Bar Chart*
 - *Making _____ from Recycled Materials: Bar Chart*
 - *Lifecycle Hopscotch Post-Test*
- A set of the teacher pages for product of choice*:
- *Making Aluminum Cans from Natural Resources and Making Aluminum Cans from Recycled Materials*
 - *Making Glass Bottles from Natural Resources and Making Glass Bottles from Recycled Materials*
 - *Making Newspaper from Natural Resources and Making Newspaper from Recycled Materials*
 - *Making Plastic Detergent Bottles from Natural Resources and Making Plastic Detergent Bottles from Recycled Materials*
 - *Making Steel Cans from Natural Resources and Making Steel Cans from Recycled Materials*

* In the teacher sets, the first handout describes a product lifecycle using natural resources and the impact to the environment, and the second handout describes the same product lifecycle using recycled materials and the impact to the environment.

In the activity you will conduct with students the linear part of the model first—the part without recycling—and then conduct the cyclical part—the part with the recycling loop added to the linear model.

Procedure

PART A

1 Explain to students that the activity they will engage in portrays the lifecycle of a product (how the product is made and what happens to it after it is used—whether recycled or landfilled), including how the environment is affected by making consumer products.

2 Over a large expanse of the classroom floor or wall (about 20 feet by 5 foot space), assemble the lifecycle model you have chosen to use. (See the Preparation section.) For the first round of Lifecycle Hopscotch, place only the steps for the linear lifecycle, (without recycling). This involves the 12 steps described on the teacher page for the product made using natural resources.

3 Explain the model to students. As you explain the model, review the symbols from the previous activity for a process, energy input, transportation energy, output and natural resource.

Decide how to add the explanations to the symbols on the model.

- Either read aloud each step, in sequence, and have a student glue the explanation onto the symbol, **or**
- Divide students into groups and give each group a set of the explanations (with the numbers not included in each cut-out description) to place on the model in the order in which they think each step happens.

The latter method takes more time but requires more thought by students.

NOTE: The latter approach is used in Part B of this activity. If you decide to

conduct Part B, use the first method above as an example.

4 After completing the linear model, explain to students that the environmental effects are missing from the model. The environmental effects are represented by using different colored fuzzies (or any item chosen to designate units). In the following scenario, red fuzzies represent natural resources, green fuzzies represent energy (both energy inputs and transportation energy) and gray fuzzies represent pollution, designated with a “P” on processes (squares) and on transportation energy (diamonds).

5 Choose one student to move or “hopscotch” through the model—**one step at a time**—collecting fuzzies from other students. The “hopscotching” student will need a container (about the size of a coffee can) to collect the fuzzies.

Have other students line up beside the model ready to hand the appropriate number and color of fuzzies to the student depending upon the step of the model he/she has hopped to.

- Give eight students a handful of gray fuzzies each and place the students beside the steps of the model with a “P” written on them.
- Give eight students a handful of green fuzzies each and place the students beside the energy (energy inputs and transportation energy) steps of the model.
- Give two students a handful of red fuzzies each and place them beside the two steps where natural resource symbols are located.

Each student in the class should have a role.

To know how many different colored fuzzies the hopscotching student should receive at each step, refer to the corresponding teacher page, (i.e. *Making Aluminum Cans from Natural Resources*, etc.) for your chosen product lifecycle.

6 Have the hopscotching student begin on the natural resource symbol for the product. The student should receive the designated amount of red fuzzies from the student beside the resource symbol. When pollution is emitted in the process (which occurs every time there is a process and transportation energy), a student role-playing pollution emissions should give the hopscotching student the designated number of gray fuzzies. When energy inputs are required (every time there is a process and transportation energy), the designated number of green fuzzies should be given to the hopscotching student.

7 Have students return to their seats, except for the hopscotching student who collected the fuzzies. Have this student sort the fuzzies by color and count how many of each color were collected. While this student is counting, give each students the handout, *Making _____ from Natural Resources: Bar Chart*. Have them write in the blank space the product being considered. On the bar chart, record the number of resource units (red fuzzies) used, the number of energy units (green fuzzies) used, and the number of pollution units (gray fuzzies) produced. Have students store these graphs in a safe place.

8 Now continue the lifecycle hopscotch game by repeating steps 5-7 above, only this time use the recycling scenario and record the environmental impacts by having each student record data on the handout, *Making _____ from Recycled Materials: Bar Chart*.

9 Have students compare the results of the two bar charts by making a single bar chart. Discuss results in class. Refer to the teacher page, *Environmental Impacts and the Product Lifecycle Models*, to aid in discussion and to ensure that the data was collected correctly for the chosen product lifecycle.

PART B

1 Conduct the rest of the activity using the four product lifecycles not used in Part A.

2 Divide students into groups and give each group a set of lifecycle steps for one product cut out from the two teacher pages. Give them the steps for both natural resources and recycled materials. DO NOT include the number of each step and distribute all four of the other products among the groups.

Decide whether to include the information about environmental impacts (the numbered items in parenthesis below each step) in the cut-out descriptions given to the groups, or wait and conduct the hopscotch game again for each product and read aloud the number of fuzzies.

3 Give each group materials and supplies sufficient to construct a lifecycle model using the set of steps they have been given. (Instead of a large classroom floor model, you could have students draw or glue the model on large sheets of paper.) Have each group construct their model.

4 Conduct the hopscotch game for each product lifecycle, collecting data (fuzzies) again and recording this data on the graphs. Or, just have student groups make their own calculations if you supplied this information with each step.

5 Have all groups share their data and graphs. Have each student or group make one large bar graph, including all five products and comparisons of all five in regard to production using natural resources only and production using recycled materials.

Once again, refer to the teacher page, *Environmental Impacts and the Product Lifecycle Models*, to aid in discussion and to ensure that data was collected correctly for each product.

6 Discuss the data and how environmental impacts differ depending upon the product. It should be noted that different products of the same material type (i.e., copy paper, newspaper, writing paper) have different impacts based on the industrial processes and other materials required to make each product.

Conducting this activity will show that although impacts vary from product to product, the use of recycled materials, generally (always when using the scenario of this lesson), produce less harmful impacts upon the environment in regard to resource and energy use, pollution and land use.

Assessment

1 Have students complete the handout, *Lifecycle Hopscotch Post-Test*.

ANSWERS to *Lifecycle Hopscotch Post-Test*: 1. d, 2. b, 3. d, 4. a

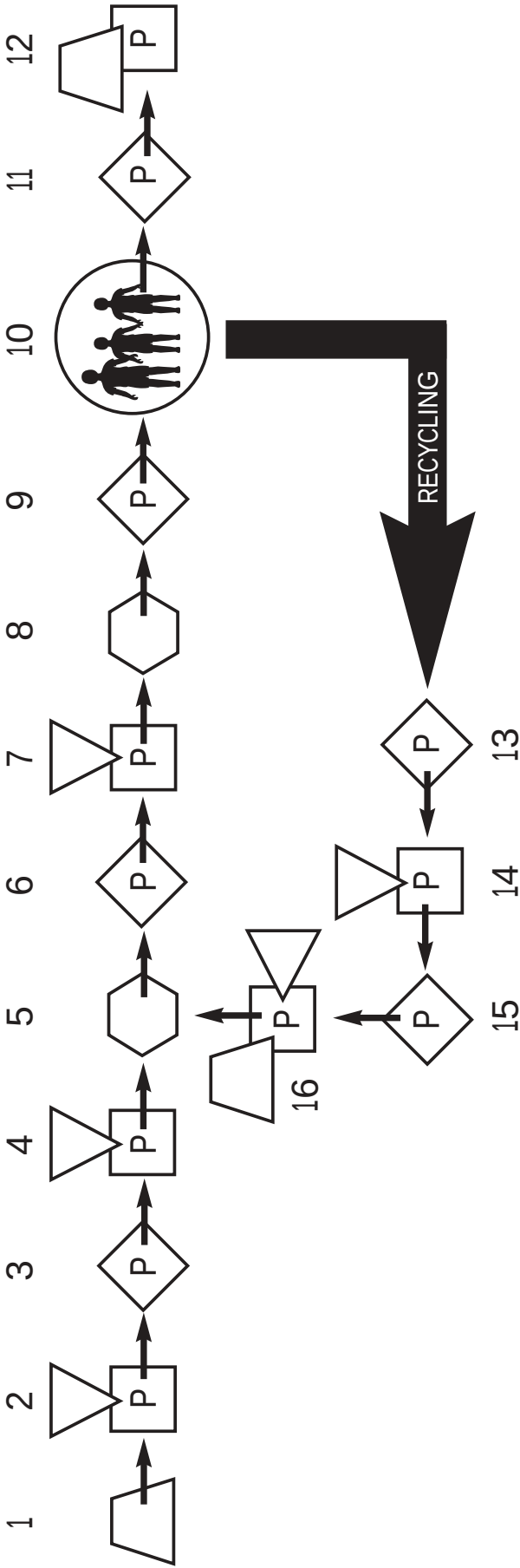
2 Have students write about the natural resources' journey through the lifecycle. Make sure that students include the steps in the lifecycle where energy inputs and natural resources were required and where pollution was emitted. Students should answer the following questions in their narrative:

- What natural resources are used to make the product?
- Where in the product's lifecycle was pollution emitted? Why?
- Where in the product's lifecycle is energy used to extract, process and transport the natural resource?

Extension

Have students research and create a lifecycle for a favorite product. Students can write about their products' lifecycle in journals, map out lifecycles with pattern blocks on the floor or make lifecycle posters.

PRODUCT LIFECYCLE MODEL



Environmental Impacts and the Product Lifecycle Models

The data below, derived from the product lifecycle models in this activity, indicate the environmental impacts for the various product lifecycles that can be used in the activity. The data, based on *hypothetical units* (“fuzzies” or other items used when conducting the lifecycle activity), indicate that recycling saves natural resources and energy, and reduces pollution. The *hypothetical units* for each environmental impact category (resources, energy and pollution), with and without recycling, differ depending upon the specific product. This represents reality to the extent that different products (glass products, paper products, plastic products, etc.) have different environmental impacts depending upon the materials and production processes used to make each product.

In this lesson, the environmental impacts (or hypothetical units-fuzzies) have been generalized based on the scheme below. *

RECYCLING REDUCES POLLUTION: aluminum, steel, paper, glass, plastic

RECYCLING REDUCES ENERGY USE: aluminum, plastic, steel, paper, glass

RECYCLING REDUCES RESOURCE USE: steel, aluminum, plastic, glass, paper

Hypothetical units (fuzzies or other items) derived when conducting the activity.			
	Natural Resources	Energy	Pollution
ALUMINUM CAN			
with natural resources	6	12	12
with recycling	2	7	7
units saved with recycling	4	5	5
GLASS BOTTLE			
with natural resources	6	11	10
with recycling	4	9	8
units saved with recycling	2	2	2
NEWSPAPER			
with natural resources	3	9	10
with recycling	2	7	7
units saved with recycling	1	2	3
PLASTIC BOTTLE			
with natural resources	3	11	9
with recycling	1	7	8
units saved with recycling	2	4	1
STEEL CAN			
with natural resources	6	10	11
with recycling	1	7	7
units saved with recycling	5	3	4

*This scheme is based on generalizations derived from the following sources:

Lester Brown, Christopher Flavin & Sandra Postel, *Saving the Planet: How to Shape an Environmentally Sustainable Global Economy* (New York: W.W. Norton & Company, 1991), p. 65; Susan M. Selke, *Packaging and the Environment: Alternatives, Trends, Solutions* (Lancaster, PA: Technomic Publishing Co., 1990), pp. 100 & 106; and John E. Young, “Mining the Earth,” *State of the World 1992: A Worldwatch Institute Report on Progress Toward a Sustainable Society* (New York: W.W. Norton & Company, 1992), p.100.

MAKING ALUMINUM CANS FROM NATURAL RESOURCES

1. Bauxite is needed.
(5 natural resource)
2. Bauxite is mined.
(2 energy input/2 pollution)
3. Bauxite is transported to an aluminum smelting plant.
(1 transportation energy/1 pollution)
4. At the aluminum plant, bauxite is refined into alumina powder and melted (smelted) in a furnace to make aluminum.
(4 energy input/4 pollution)
5. Product: large sheets of aluminum.
6. Sheets of aluminum are delivered to a manufacturing plant.
(1 transportation energy/1 pollution)
7. Sheets of aluminum are made into cans and filled with a beverage.
(1 energy input/1 pollution)
8. Product: aluminum cans filled with beverage.
9. Filled aluminum cans are delivered to a store.
(1 transportation energy/1 pollution)
10. Customer buys and uses product, then discards the aluminum can.
11. Aluminum cans, along with other solid waste items, are collected and transported to a landfill.
(1 transportation energy/1 pollution)
12. Aluminum cans and other solid waste items are buried in a landfill.
(1 natural resource/1 energy input/1 pollution)

MAKING ALUMINUM CANS FROM RECYCLED MATERIALS

START SECOND ROUND OF GAME HERE

10. Customer buys and uses product, then recycles the aluminum can.
11 & 12 not included as the need for landfill space is saved.
13. Aluminum cans, along with other recyclables, are collected and transported to a recycling center or municipal recovery facility (MRF).
(1 transportation energy /1 pollution)
14. Aluminum cans are separated from other recyclables and baled.
(1 energy input/1 pollution)
15. The recycling center ships the aluminum cans to an aluminum smelting facility.
(1 transportation energy/1 pollution)
16. At the aluminum smelting facility, old cans are mixed with alumina powder – replacing a large amount of bauxite – and melted in a furnace.
(2 natural resource/1 energy input/1 pollution)

Prior to Step 16, the following may be inferred:

1. Less bauxite was needed.
2. Less bauxite was mined.
3. Less bauxite was transported to an aluminum smelting plant.
4. At the aluminum plant, less bauxite was refined into alumina powder and melted (smelted) in a furnace to make aluminum.

NOW: GO TO STEP 5 AND FINISH WITH STEP 9.

5. Product: large sheets of aluminum.
6. Sheets of aluminum are delivered to a manufacturing plant.
(1 transportation energy/1 pollution)
7. Sheets of aluminum are made into cans and filled with a beverage.
(1 energy input/1 pollution)
8. Product: aluminum cans filled with beverage.
9. Filled aluminum cans are delivered to a store.
(1 transportation energy/1 pollution)

MAKING GLASS BOTTLES FROM NATURAL RESOURCES

1. Sand, soda ash and limestone are needed.
(5 natural resource)
2. Sand, soda ash and limestone are mined.
(2 energy input/2 pollution)
3. Sand, soda ash and limestone are transported to a glass plant.
(1 transportation energy/1 pollution)
4. At the glass plant, sand, soda ash and limestone are mixed together and melted in a furnace to form gobs that are dropped into molds to make glass bottles.
(3 energy input/2 pollution)
5. Product: glass bottles.
6. Glass bottles are delivered to a beverage plant.
(1 transportation energy/1 pollution)
7. Glass bottles are filled with beverage.
(1 energy input/1 pollution)
8. Product: glass bottles filled with beverage.
9. Filled glass bottles are delivered to a store.
(1 energy input/1 pollution)
10. Customer buys and uses product, then discards the glass bottle.
11. Glass bottles, along with other solid waste items, are collected and transported to a landfill.
(1 transportation energy/1 pollution)
12. Glass bottles and other solid waste items are buried in a landfill.
(1 natural resource/1 energy input/1 pollution)

MAKING GLASS BOTTLES FROM RECYCLED MATERIALS

START SECOND ROUND OF GAME HERE

10. Customer buys and uses product, then recycles the glass bottle.
11 & 12 not included as the need for landfill space is saved.
13. Glass bottles and jars, along with other recyclables, are collected and transported to a recycling center or municipal recovery facility (MRF).
(1 transportation energy/1 pollution)
14. At the recycling center, glass bottles and jars are separated by color from other recyclables— clear, green and amber.
(2 energy input/ 2 pollution)
15. The recycling center ships the cullet to a glass plant.
(1 transportation energy/1 pollution)
16. At the plant, the color-separated glass is crushed into small pieces called cullet. This cullet is mixed with sand, soda ash and limestone (replacing some of the sand, soda ash and limestone) and melted in a furnace to form gobs that are dropped into molds to make glass bottles.
(4 natural resource/2 energy input/1 pollution)

Prior to Step 16 the following may be inferred:

1. Less sand, soda ash and limestone was needed.
2. Less sand, soda ash and limestone was mined.
3. Less sand, soda ash and limestone was transported to a glass plant.
4. At the glass plant, less sand, soda ash and limestone was mixed together and melted in a furnace to form gobs that are dropped into molds to make glass bottles.

NOW: GO TO STEP 5 AND FINISH WITH STEP 9.

5. Product: glass bottles.
6. Glass bottles are delivered to a beverage plant.
(1 transportation energy/1 pollution)
7. Glass bottles are filled with beverage.
(1 energy input/1 pollution)
8. Product: glass bottles filled with beverage.
9. Filled glass bottles are delivered to a store.
(1 energy input/1 pollution)

MAKING NEWSPAPER FROM NATURAL RESOURCES

1. Trees are needed.
(2 natural resource)
2. Trees are harvested.
(1 energy input/1 pollution)
3. Trees are transported to a paper mill.
(1 transportation energy/1 pollution)
4. At the paper mill, trees are cut into wood chips. The wood chips are soaked in chemicals to make pulp, which is stretched out into large sheets of paper. The large sheets of paper are cut into large rolls of paper.
(2 energy input/ 3 pollution)
5. Product: large rolls of paper.
6. Large rolls of paper are delivered to a newspaper printing facility.
(1 transportation energy/1 pollution)
7. Rolls of paper are printed on and cut into sheets to make a newspaper.
(1 energy input/1 pollution)
8. Product: newspaper.
9. Newspapers are delivered to a store or distributor.
(1 transportation energy/1 pollution)
10. Customer buys and uses the newspaper, then discards it.
11. Old newspapers, along with other solid waste items, are collected and transported to a landfill.
(1 transportation energy/1 pollution)
12. Old newspaper and other solid waste items are buried in a landfill.
(1 natural resource/1 energy input/1 pollution)

MAKING NEWSPAPER FROM RECYCLED MATERIALS

START SECOND ROUND OF GAME HERE

10. Customer buys and uses newspaper, then recycles it.
11 & 12 not included as the need for landfill space is saved.
13. Old newspapers, along with other recyclables, are collected and transported to a recycling center or municipal recovery facility (MRF).
(1 transportation energy/1 pollution)
14. Old newspapers are separated from other recyclables and baled.
(1 energy input/1 pollution)
15. The recycling center ships the newspaper bales to a paper mill.
(1 transportation energy/1 pollution)
16. Waste paper is pulped and added to wood chips – replacing some wood chips/trees– and made into large rolls of paper.
(2 natural resources/1 energy input/1 pollution)

Prior to Step 16, the following may be inferred:

1. Fewer trees, a renewable natural resource, were needed.
2. Fewer trees were harvested.
3. Fewer trees were transported to a paper mill.
4. At the paper mill, fewer trees were cut into wood chips. The wood chips were soaked in chemicals to make a pulp, which was stretched out into large sheets of paper. The large sheets of paper were cut into large rolls of paper.

NOW: GO TO STEP 5 AND FINISH WITH STEP 9.

5. Product: large rolls of paper.
6. Large rolls of paper are delivered to a newspaper printing facility.
(1 transportation energy/1 pollution)
7. Rolls of paper are printed on and cut into sheets to make a newspaper.
(1 energy input/1 pollution)
8. Product: newspaper.
9. Newspapers are delivered to a store or distributor.
(1 transportation energy/1 pollution)

MAKING PLASTIC DETERGENT BOTTLES FROM NATURAL RESOURCES

1. Petroleum or natural gas is needed.
(2 natural resource)
2. Petroleum or natural gas is extracted from the ground.
(1 energy input/1 pollution)
3. Petroleum or natural gas is transported to a plastics factory.
(1 transportation energy/1 pollution)
4. At the plastics factory, petroleum or natural gas is heated and changed into polymers or plastic resins. The resins are melted and blown through molds that turn the resins into plastic bottles.
(4 energy input/2 pollution)
5. Product: plastic bottles.
6. Plastic bottles are shipped to a detergent factory.
(1 transportation energy/1 pollution)
7. At the factory, plastic bottles are filled with liquid detergent.
(1 energy input/1 pollution)
8. Product: plastic bottles filled with detergent.
9. Filled plastic bottles are delivered to a store.
(1 transportation energy/1 pollution)
10. Customer buys and uses the product, then discards the bottle.
11. Plastic bottles, along with other solid waste items, are collected and transported to a landfill.
(1 transportation energy/1 pollution)
12. Plastic bottles and other solid waste items are buried in a landfill.
(1 natural resource/1 energy input/1 pollution)

MAKING PLASTIC DETERGENT BOTTLES FROM RECYCLED MATERIALS

START SECOND ROUND OF GAME HERE

10. Customer buys and uses the product, then recycles the bottle.
11 & 12 not included as the need for landfill space is reduced.
13. Plastic bottles, along with other solid waste items, are collected and transported to a recycling center or municipal recovery facility (MRF).
(1 transportation energy/1 pollution)
14. Plastic bottles are separated from other recyclables, compacted and baled.
(1 energy input/1 pollution)
15. Plastic bottles are transported to a plastic resin producer where the bottles are chopped, washed and converted into flakes or pellets.
(1 transportation energy/1 energy input/2 pollution)
16. The flakes or pellets (which replace petroleum or natural gas) are melted and blown through a mold and removed in the shape of plastic bottles.
(1 natural resource/1 energy input/1 pollution)

Prior to Step 16, the following may be inferred:

1. Less petroleum or natural gas was needed.
2. Less petroleum or natural gas was extracted from the ground.
3. Less petroleum or natural gas was transported to a plastics factory.
4. At the plastics factory, less petroleum or natural gas was heated and changed into polymers or plastic resins. The resins were melted and blown through molds that turned the resins into plastic bottles.

NOW: GO TO STEP 5 AND FINISH WITH STEP 9.

5. Product: plastic bottle.
6. Plastic bottles are shipped to a detergent factory.
(1 transportation energy/1 pollution)
7. At the factory, plastic bottles are filled with liquid detergent.
(1 energy input/1 pollution)
8. Product: plastic bottles filled with detergent.
9. Filled plastic bottles are delivered to a store.
(1 transportation energy/1 pollution)

MAKING STEEL CANS FROM NATURAL RESOURCES

1. Iron ore, coal and limestone are needed.
(5 natural resource)
2. Iron ore, coal and limestone are mined.
(2 energy input/2 pollution)
3. Iron ore, coal and limestone are transported to a steel mill.
(1 transportation energy/1 pollution)
4. Iron ore, coal, limestone and other alloys are melted in a furnace to make steel.
(2 energy input/ 3 pollution)
5. Product: large sheets of steel.
6. Sheets of steel are transported to a manufacturing plant.
(1 transportation energy/1 pollution)
7. The sheets of steel are made into cans and filled with vegetables.
(1 energy input/1 pollution)
8. Product: steel cans filled with vegetables.
9. Filled steel cans are delivered to a store.
(1 transportation energy/1 pollution)
10. Customer buys and uses product, then discards the can.
11. Steel products, along with other solid waste items, are collected and transported to a landfill.
(1 transportation energy/1 pollution)
12. Steel cans and other solid waste items are buried in a landfill.
(1 natural resource/1 energy input/1 pollution)

MAKING STEEL CANS FROM RECYCLED MATERIALS

START SECOND ROUND OF GAME HERE

10. Customer buys and uses product, then recycles the can.
11 & 12 not included as the need for landfill space is reduced.
13. Steel cans, along with other solid waste items, are collected and transported to a recycling center or municipal recovery facility (MRF).
(1 transportation energy/1 pollution)
14. Steel cans are separated from other recyclables and shredded.
(1 energy input/1 pollution)
15. Shredded steel is shipped to a steel mill.
(1 transportation energy/1 pollution)
16. At a steel mill, the old shredded steel is mixed with iron ore, coal, limestone and other alloys and melted in a furnace to make steel.
(1 natural resource/1 energy input/1 pollution)

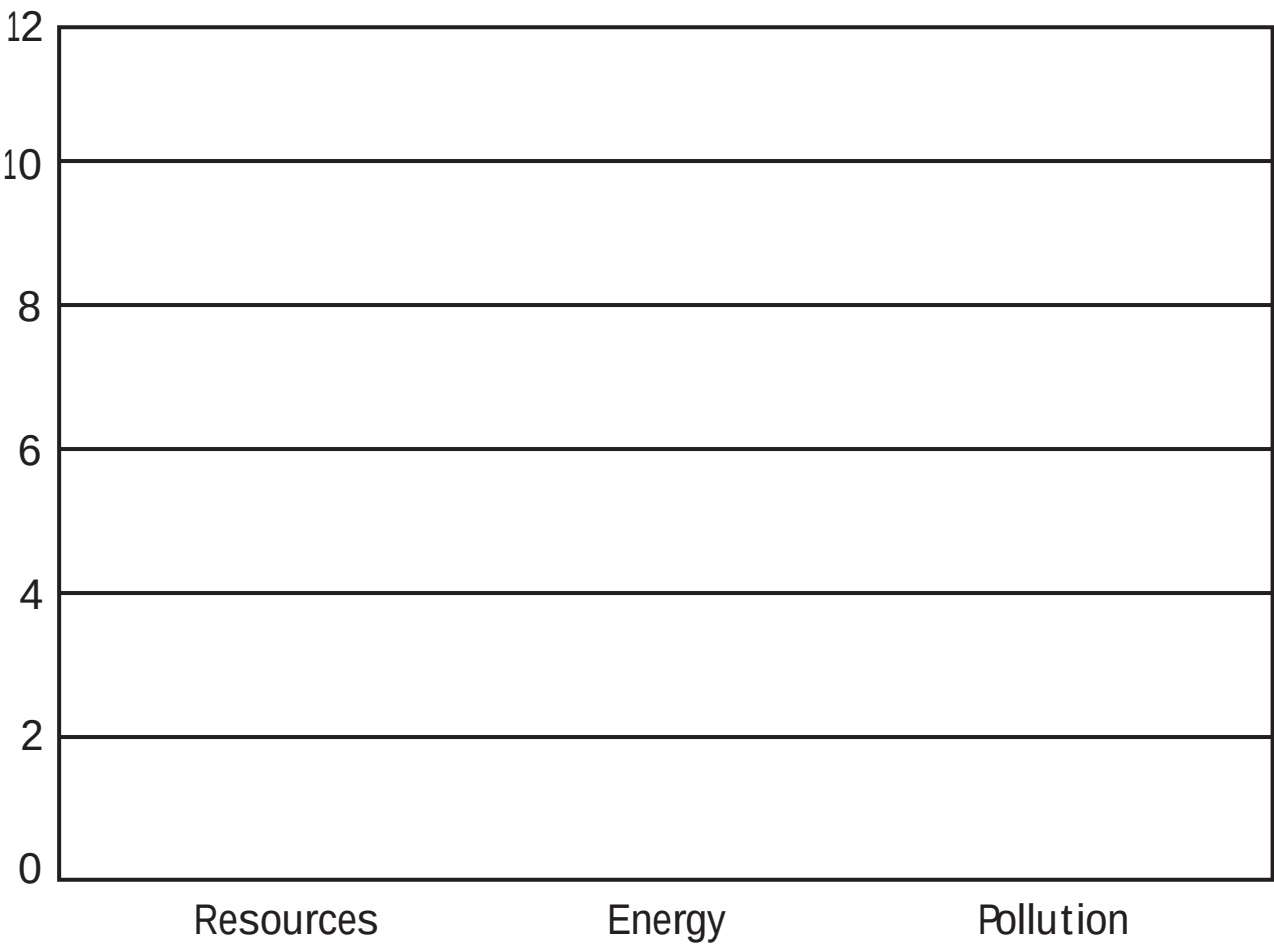
Prior to Step 16, the following may be inferred:

1. Less iron ore, coal and limestone was needed.
2. Less iron ore, coal and limestone was mined.
3. Less iron ore, coal and limestone was transported to a steel mill.
4. Less iron ore, coal and limestone and other alloys was melted in a furnace to make steel.

NOW: GO TO STEP 5 AND FINISH WITH STEP 9.

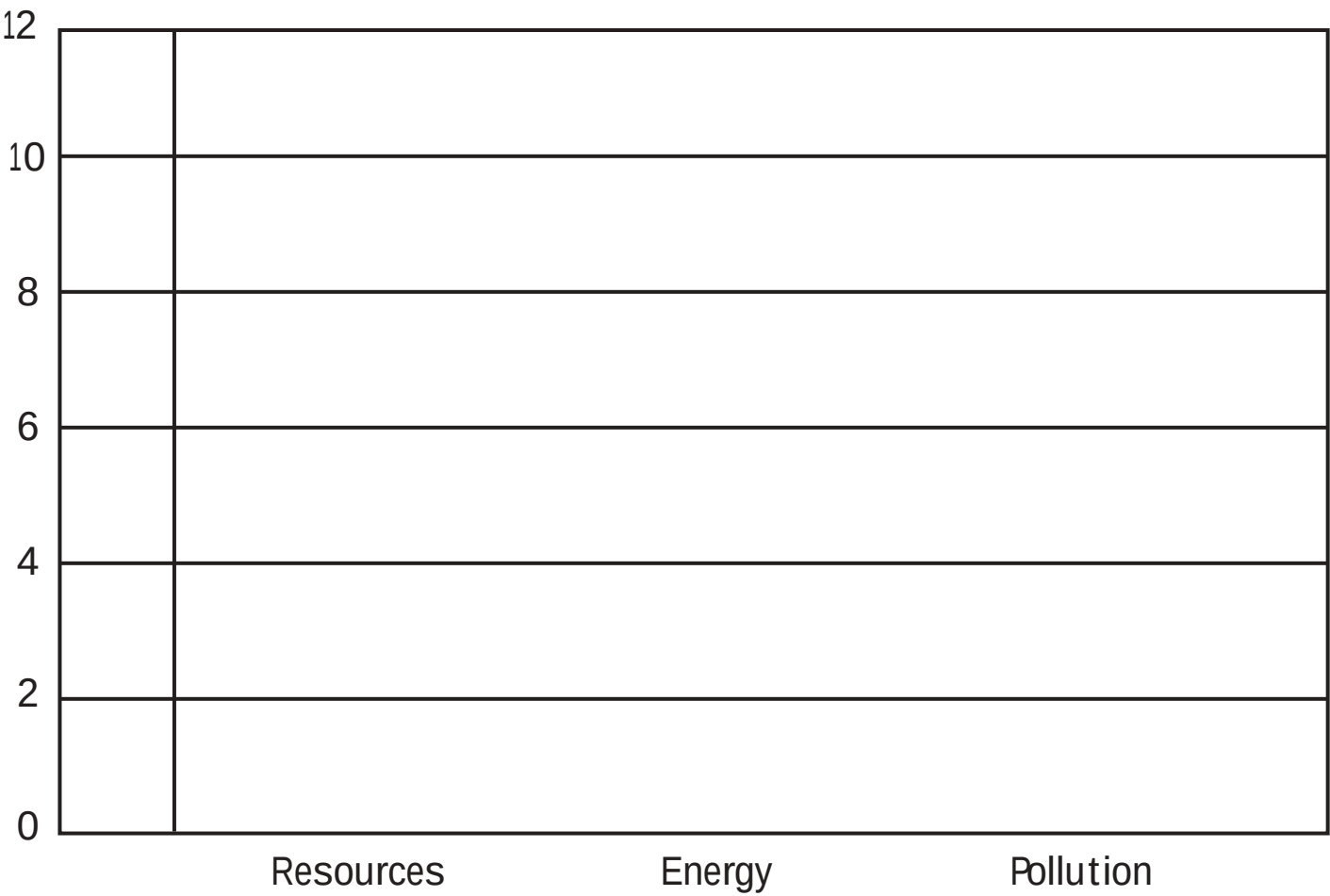
5. Product: large sheets of steel.
6. Sheets of steel are transported to a manufacturing plant.
(1 transportation energy/1 pollution)
7. The sheets of steel are made into cans and filled with vegetables.
(1 energy input/1 pollution)
8. Product: steel cans filled with vegetables.
9. Filled steel cans are delivered to a store.
(1 transportation energy/1 pollution)

MAKING _____ FROM NATURAL RESOURCES BAR CHART



Student Handout

MAKING _____ FROM RECYCLED MATERIALS BAR CHART



Student Handout



LIFECYCLE HOPSCOTCH POST-TEST

Directions: Put the letter of the correct response in the space next to the number.

- _____ 1. What happens during a lifecycle (manufacturing process)?
- a. natural resources are consumed
 - b. pollution is emitted
 - c. energy is required
 - d. all of the above
- _____ 2. When a product is made using raw materials instead of recycled materials, which one of the following statements is generally true?
- a. less energy is required
 - b. more natural resources are used
 - c. less natural resources are used
 - d. less pollution is emitted
- _____ 3. When a product is made using recycled materials instead of raw materials, which one of the following statements is generally true?
- a. more energy is required
 - b. more natural resources are used
 - c. more pollution is emitted
 - d. less energy is required
- _____ 4. In the lifecycle of a product, when is pollution always emitted?
- a. process
 - b. natural resources
 - c. output
 - d. none of the above



NATURE'S WAY WITH WASTE

Environmental Studies Learning Concept

All life on Earth depends on an efficient recycling system in nature – a complex system of nutrient and energy flows. Nutrients, in food and water, are passed through food chains from plants to herbivores to carnivores (producers to consumers) and finally to decomposers who return nutrients to the soil to be used by plants again.

The flow of nutrients through an ecosystem occurs as energy is transformed from one state to another. Green plants chemically convert sunlight into food energy for animals, and animals convert this food-chemical energy into kinetic energy for movement and thermal energy for warmth.

Natural ecosystems efficiently recycle nature's solid waste (dead plants and animal matter) through biochemical cycles that rely on decomposers to change organic matter (once living) into nutrients (non-living) that are deposited in soil to be absorbed and used by green plants again. Organic matter from plants affects soil texture and nutrient composition.

Nature's recycling process is similar to the composting of organic solid waste material. A large portion of solid waste is organic or biodegradable and can be composted. Composted materials include food waste and yard waste. Composting saves land space and enhances soil quality. Artificial solid waste, such as inorganic packaging materials, will not efficiently biodegrade and must either be landfilled or recycled.

Vocabulary

artificial – not genuine or real, unnatural; made by human skill

bacteria – any of the numerous microscopic, spherical, rod-shaped or spiral organisms that play a role in the fixing of atmospheric nitrogen

biodegradation – the process of decaying elements or cells of dead plants and animals into simpler substances that are absorbed by the environment

compost – a nutrient-rich humus; a mixture of various decaying organic substances, such as dead leaves, manure, etc. used for fertilizing land

composting – the natural decomposition of organic waste materials through the action of microorganisms that results in compost

cycles – any complete round or series of occurrences that repeats or is repeated

decomposer – an organism, usually a bacterium or fungus, that breaks down the cells of dead plants or animals into smaller substances

decomposition – the breakdown of organic matter by microbial action

degrade – the breaking down of organic matter

ecosystem – a complex system made up of the interactions between living and non-living components

energy – the capacity to perform work, includes the activities of plants, animals and human beings

energy transformations – the act of transforming energy from one state to another

food chain – a series of organisms interrelated in their feeding habits, the smallest being fed upon by a larger being

food waste – with regard to compost, wastes such as fruits, rinds, egg shells, coffee grounds; nothing that would be considered remains of another animal

fungi – any of the numerous thallophytes characterized by a lack of chlorophyll and subsist upon organic matter (i.e. mushrooms, molds, mildews, rusts and smuts)

humus – the dark organic material in soils, produced by decomposition of vegetable or animal matter, and essential to the fertility of the earth

inorganic – substance in which carbon-to-carbon bonds are absent; mineral matter

municipal solid waste (MSW) – includes garbage and trash, that originates in households, commercial establishments, or construction and demolition sites

natural – existing in or formed by nature (opposed to artificial)

nutrients – a substance taken by a cell from its environment and used in catabolic or anabolic reactions

organic – once living matter

packaging (natural and artificial) – a container or wrap in which something may be packed to preserve matter

recycling – the act of collecting and separating materials from the waste stream and reusing them as raw materials in manufacturing processes

scavengers – any of various animals or organisms feeding on dead organic matter

soil – a mixture of mineral and organic material and decomposer organisms (mainly bacteria and fungi)

vermicomposting – the process of using earthworms and microorganisms to convert organic waste into black, earth-smelling nutrient-rich humus

waste – crop residues; animal dung

Overview - NATURE'S WAY WITH WASTE



Activity 1: The Great Cycle

1

Description

Students *read* a story about nature's recycling system and *interpret* vocabulary words. Using visual representations of recycling, they *make inferences* about energy and nutrient flows in natural ecosystems. Students *analyze* composting as a beneficial human activity.

Ohio Proficiency Test Learning Outcomes

Grade 4, Reading #14 – Identify and interpret vocabulary (words, phrases or expressions) critical to understanding the text.

Grade 4, Reading #17 – Infer from the text.

Grade 4, Reading #18 – Respond to the text.

Grade 4, Science #5 – Analyze a series of events and/or simple daily or seasonal cycles and predict the next likely occurrence in the sequence.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 4, Science #16 – Demonstrate an understanding of the basic needs of living things.

Grade 4, Science #18 – Distinguish between living and non-living things and provide justification for these distinctions.

Grade 6, Reading #11 – Summarize the text.

Grade 6, Reading #12 – Infer from the text.

Grade 6, Reading #13 – Respond to the text.

Grade 6, Science #4 – Identify the positive and/or negative impacts of technology on human activity.

Grade 6, Science #14 – Trace the transmission of energy in a small, simple ecosystem and/or identify the roles of organisms in the energy movement in an ecosystem.

Grade 6, Science #17 – Analyze the impacts of human activity on the ecosystems of the Earth.

Summary

This lesson consists of five activities. Although each activity may be conducted separately, it will be helpful for students to conduct Activity 4 before using Activity 5.

Activity 2: Bio-What? That's Biodegradation!

2

Description

Students *analyze* packaging as a source of nutrient preservation to meet the cultural and energy needs of humans. They *compare* artificial packaging with nature's and *make inferences* about the rates of decomposition of various solid waste materials and the value of composting as a waste reduction process. Students perform a simple decomposition experiment using organic and inorganic matter in plastic bags.

Ohio Proficiency Test Learning Outcomes

Grade 4, Science #4 – Use a simple key to distinguish between objects.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 4, Science #18 – Distinguish between living and non-living things and provide justification for these distinctions.

Grade 4, Writing – Given an assigned activity direction intended to elicit modes of writing, the learner will use the writing process to make the intended clear, as evidenced by: (#1) a response that stays on the topic; (#2) the use of detail to support the topic; and (#7) a response that shows an awareness of word usage – vocabulary, homonyms and words in context.

Grade 6, Science #1 – Use a simple key to classify objects, organisms and/or phenomena.

Grade 6, Science #3 – Make inferences from observations of phenomena and/or events.

Activity 3: Compost Critters

Description

Students *observe* the types of living organisms in a compost pile and *describe* the role of scavengers and decomposers in nature's recycling and sanitation process. They *analyze* the handout, *Food Web of the Compost Pile*, and *identify* the active decomposers and scavengers in actual compost with magnifying glasses, hand lenses or microscopes.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #17 – Apply the use of tools to measure lengths, using centimeters and inches including recognizing the positions of whole numbers and fractions on a number line.

Grade 4, Science #3 – Identify and compare the mass, dimensions and volume of familiar objects in standard and non-standard units.

Grade 4, Science #4 – Use a simple key to distinguish between objects.

Grade 4, Science #6 – Evaluate a simple procedure to carry out an exploration.

Grade 4, Science #7 – Identify and/or discuss the selection of resources and tools used for exploring scientific phenomena.

Grade 4, Science #9 – Demonstrate an understanding of safe use of materials and/or devices in a science activity.

Grade 4, Science #16 – Demonstrate an understanding of the basic needs of living things.

Grade 4, Science #17 – Identify ways in which organisms react to changing environments.

Grade 6, Science #1 – Use a simple key to classify objects, organisms and/or phenomena.

Grade 6, Science #2 – Identify the potential hazards and/or precautions involved in scientific investigations.

Grade 6, Science #3 – Make inferences from observations of phenomena and/or events.

Grade 6, Science #14 – Trace the transmission of energy in a small, simple ecosystem and/or identify the roles of organisms in the energy movement in an ecosystem.

Grade 6, Science #15 – Compare and/or contrast the diverse ways living things meet their needs.

Activity 4: Meet the YIMBYs

Description

Students *cooperate* as a group to role-play the components of a compost pile. Throughout this activity, students *apply knowledge* by using such skills as *differentiation*, *categorization*, *synthesis*, *explanation* and *evaluation*.

Ohio Proficiency Test Learning Outcomes

Grade 4, Science #4 – Use a simple key to distinguish between objects.

Grade 4, Science #16 – Demonstrate an understanding of the basic needs of living things.

Grade 4, Science #18 – Distinguish between living and non-living things and provide justification for these distinctions.

Grade 6, Science #1 – Use a simple key to classify objects, organisms and/or phenomena.

Grade 6, Science #3 – Make inferences from observations of phenomena and/or events.

Activity 5: Compost Jars

Description

Students *observe* and *compare* various soil samples and record data. They *manipulate* equipment to make individual compost jars. They *compare* various types of soils to the compost soil. Students *interpret* data to *infer* the value of compost. Using an experimental approach will enhance *observing*, *hypothesizing* and data *interpretation* skills.

Ohio Proficiency Test Learning Outcomes

Grade 4, Science #2 – Select instruments to make observations of an event, object or organism.

Grade 4, Science #6 – Evaluate a simple procedure to carry out an exploration.

Grade 4, Science #7 – Identify and/or discuss the selection of resources and tools used for exploring scientific phenomena.

Grade 4, Science #9 – Demonstrate an understanding of safe use of materials and/or devices in a science activity.

Grade 6, Science #2 – Identify the potential hazards and/or precautions involved in scientific investigations.

Grade 6, Science #3 – Make inferences from observations of phenomena and/or events.

Grade 6, Science #12 – Identify characteristics and/or patterns in rocks and soil.

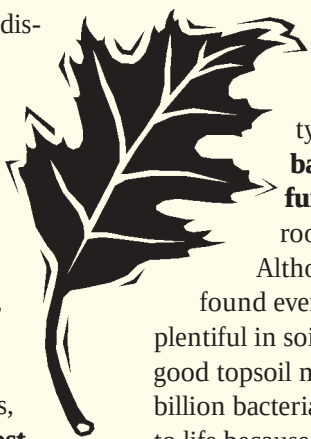
Background Information

National statistics indicate that leaves, brush and other organic wastes account for more than 30 percent of our **municipal solid waste stream** (MSW). Yard waste alone is the second largest component of the waste stream (paper and paper products is the largest component). The disposal of these materials is becoming increasingly difficult for communities across the state, country and around the world. Strict environmental regulations on landfills and incinerators increase the costs of disposal, so communities continue to search for environmentally-sound solid waste alternatives, such as **recycling** and **composting**. Benefits of recycling organic materials include: conserving **energy** and natural resources, improving much-needed topsoil and reducing landfill space.

Nature recycles its solid waste (dead plant and animal matter) through **biochemical cycles**. Decomposers change once-living organic matter into non-living nutrients that are deposited in the soil to be absorbed and used again and again by green plants. Nature's recycling process resembles the composting of organic solid waste material. A large portion of solid waste, such as **food waste** and yard waste, can be composted because it is **organic** and will decompose.

All life on Earth depends upon nature's efficient recycling system, which involves a complex system of nutrients and flows of energy. **Nutrients** in food and water are passed through **food chains** from plants to herbivores to carnivores – producers to consumers – and finally to **decomposers** who return nutrients

to the soil to be used again by plants. Nutrients flow through an **ecosystem** as **energy is transformed** from one state to another. Green plants chemically convert sunlight into food energy for animals, and animals convert this chemical energy into kinetic energy for movement and thermal energy for warmth.



Decomposers are part of every food chain.

They include different types of microscopic **bacteria** and various **fungi** (molds, mushrooms, mildews).

Although decomposers are found everywhere, they are most plentiful in soil. A single tablespoon of good topsoil may contain up to four billion bacteria. Bacteria are essential to life because they renew nutrients to the soil as they break down waste. Soil rich in nutrients from the breakdown of organic materials by fungi and bacteria is called **humus**. The humus left behind by bacteria also gives soil the necessary texture to retain proper moisture.

Decomposers are not the only organisms breaking down waste and dead matter. In fact, sometimes before decomposers can do their work, waste matter must be broken down by larger organisms called **scavengers**. Scavengers include insects (ants, beetles, termites), aquatic creatures (fish, snails), birds (sea gulls, crows, vultures), and mammals (raccoons, rats, bears). Large scavengers (vultures, rats, hyenas) work on bulk waste, such as carcasses. Small scavengers (insects, earthworms, centipedes, slugs, snails) also work on bulk waste and smaller bits of decaying plant and animal matter, breaking it down into tiny pieces for the decomposers.

Scavengers prepare food for decomposers in another way. They consume living or dead matter and

metabolize it, leaving behind excrement or dung on which bacteria feed. As the bacteria feed on waste, they leave behind chemical compounds, which are nutrients that green plants can absorb. Together, scavengers and decomposers act as nature's sanitation crew!

Basic Composting

Compost is a mixture of various decaying organic substances that add texture and nutrients in the form of humus. Nutrients are needed for good plant growth. Texture allows the soil to retain nutrients, moisture and oxygen over a longer period of time.

Nature has its own method of producing compost. In **natural** surroundings, leaves and branches fall to the ground and form a rich, moist layer of mulch that protects the roots of plants and provides a home for nature's most fundamental recyclers: the insects, microorganisms and bacteria. Through this biological process, soil-enriching compost, carbon dioxide, heat and water are all produced. See the *Flow Chart for the Composting Process* on p. V-9.

Composting is an age-old recipe. Ancient Romans learned they could create rich and healthy soil by plowing composted animal manure and vegetation into their agricultural fields. Two early-American farming presidents, George Washington and Thomas Jefferson, believed composting made their soils healthier.

By properly managing air and moisture, the composting process can transform large quantities of organic matter into humus (compost) over a relatively short period of time. A good small-scale example is a backyard compost pile that includes both carbon-rich and nitrogen-rich materials. The carbon-rich components of a compost pile are often referred to as the "brown" material. Carbon-rich

materials include woody materials, dead leaves and dried, brown grass or straw. Nitrogen-rich components are the “green” materials and include fresh grass clippings, nuts, fruit and vegetable remains, and livestock manure.

Composters can mix approximately 75 percent “brown” organic materials with approximately 25 percent “green” organic materials (by volume), or a 3:1 ratio of brown to green materials. These ingredients, with the addition of water, oxygen, heat and compost organisms (both microscopic and macroscopic), will **degrade** and become compost.

Five Essential Ingredients

After a compost pile is built, nature does most of the work. The home composter only needs to gather the raw materials and bring them together in a manner that facilitates the process. The composting process requires five ingredients: organic matter, nitrogen, bacteria, water and oxygen.

Organic matter includes leaves, grass clippings, garden plants, weeds, nuts, straw, animal manure and vegetable trimmings. A variety of materials is desirable and a ratio of three parts fibrous matter (leaves and fibrous matter) to one part nitrogenous matter (animal manure, not pet waste) works best.

Nitrogen is another key element in the composting process. In a compost pile, leaves and fibrous materials

usually require the addition of nitrogen. Fertilizers, such as 10-10-10, 5-10-5, or blood meal, cottonseed or soybean meal, can be used for this purpose.

Bacteria and fungi are largely responsible for the composting process. Since beneficial bacteria, fungi and other decomposers live in soil and vegetable matter, their presence is assured.

Water is essential. The organisms that speed decomposition need a warm, moist environment. Some materials, such as fresh grass clippings and food waste, already have a high water content and will add moisture to the pile. If the compost is dry and flaky, water can be added with a pitcher or garden hose. The pile should be about as wet as a wrung-out sponge. If the pile is waterlogged, the bacteria and other beneficial organisms will not get enough air.

Lack of moisture will delay the composting process. Since leaves usually contain little moisture, a pile with large quantities of leaves usually requires the addition of water. Too much wet material will cool the pile and can cause organisms to become dormant and inactive. Generally, the initial moisture will stay adequate by adding grass clippings, vegetable trimmings, weeds and/or garden plants.

Oxygen is vital because composting is essentially an aerobic (in the presence of air) process. Bacteria require oxygen to live and multiply. If the air supply is cut off, anaerobic bacteria will take over and unpleasant odors and poor quality compost may result. The pile should be turned approximately every four or five days and when new material is added.

If your compost pile contains mostly leaves, consider adding some ground limestone to neutralize the acidity of the finished product.

Compost made from a variety of materials tends to be neutral and

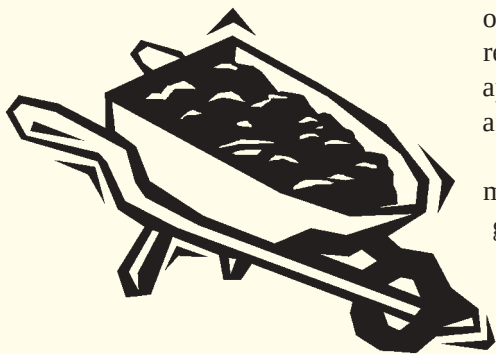
therefore does not require lime.

The following items should **NOT** be composted: meat scraps, fish scraps, bones, dairy products, peanut butter, cooking oil, diseased vegetation, animal fats, household pet wastes, plywood or pressure-treated wood, commercial potting soil and anything **inorganic** that will not **biodegrade** (e.g. plastics). These items can attract pests, generate foul odors, or contaminate or infect the compost. Most food waste (except those listed above) can be included in the pile. To avoid attracting flies, control odors and aid the **decomposition** process, bury food scraps 8 inches to 1 foot beneath the surface of the pile. Food remains can also be covered with leaves, straw or sawdust.

Vermicomposting

Earthworms enrich the growing medium, soil. **Vermicomposting** (worm bin composting) has become a popular way to recycle most kitchen food waste. Worm bins can be kept inside, do not need much material and do not create odors. In three to four months, the finished vermicompost (which is twice as rich in nutrients as regular compost) can be used to start seed, transplant seedlings, put on flower or vegetable beds, or used around trees and shrubs.

Worms play a major role in breaking down plant matter. Earthworms eat fallen leaves and other plant parts. Their droppings, called “castings,” fertilize the **soil**. As worms tunnel into the earth, they move leaves and other organic matter downward and bring deeper soil to the surface. This tunneling and mixing aerates the soil so that roots and water penetrate more easily. Earthworms and other decomposers assist the larger and smaller scavengers in keeping our Earth free of nature's litter.



Background Information, continued

Some earthworm species live in leaf litter, while others dwell several meters below the soil surface. The best worms to use are red worms. Red worms consume a lot of organic matter, survive well in captivity and reproduce quickly. Red worms are not the same worms found in garden soil, but can be found in garden, leaf and compost piles, or manure piles around stables and barns. Red worms can be bought at bait shops. If red worms cannot be obtained locally, see the Bibliography section.

Compost Bins

Although many people prefer to use an enclosure or container for composting, bins are not essential to the process, and composting can occur in open piles. The choice of a bin or open pile is usually based on aesthetic considerations. Bins can be made of logs or poles laid log-cabin fashion; cinder blocks laid without mortar and with air spaces between them; snow fence or chicken wire supported by upright posts; a steel barrel with the bottom removed and holes punched in the sides; or a variety of other ways. Also, compost bins may be purchased at retail stores. All bins should have an easy opening to turn and retrieve the compost.

Composting on a Large Scale

Large-scale municipal composting uses the same principles of organic decomposition. Facilities can process thousands of tons of organic material each year. Composting facilities accept materials, such as yard trimmings, food scraps, biosolids, wood shavings and soiled paper. After processing (shredding, turning and mixing), materials are turned into compost in eight to 24 weeks. There are more than 3,000 composting facilities around the country, processing tons

of organic material that would otherwise be sent to landfills.

Is Composting Recycling?

According to the United States Environmental Protection Agency (U.S. EPA), composting is recycling and an essential tool for states reaching recycling goals. Today, more than 25 states consider yard waste composting as recycling and 15 currently count solid waste composting in their state recycling goals. Adding composting to traditional recycling methods can divert as much as 70 percent of the waste stream to beneficial use rather than disposal.

Bibliography and Additional Resources

Student Resources

Books

Compost Critters, by Bianca Lavies, New York: Dutton Children's Books, 1993.

The Magic School Bus Meets The Rot Squad, New York: Scholastic Productions, 1995.

Worms Eat My Garbage, by Mary Appelhof, Kalamazoo, Michigan: Flower Press, 1993.

Compost! Growing Gardens From Your Garbage, by Linda Glaser, Connecticut: Millbrook Press, 1996.

Lots of Rot, by Vickie Cobb, New York: Harper Collins, 1991.

Squirmy, Wormy Composters, by Bonnie Kalman and Janine Schaub, New York: Crabtree Publishing Company, 1992.

Composting Matters, EHMI (Environmental Hazards Management Institute), 1995, (603) 868-1496.

Home Composting Wheel, EHMI, 1994.

Videos

Biodiversity and Garbage, Bill Nye The Science Guy, Disney Educational Productions, 1995.

21st Century Home Composting. The Earth Machine, Norseman Plastics, 1992.

The Complete Home Composting Video Guide With Howard Stenn, Vernal Productions, 1993.

Pollution Solutions, Bill Nye The Science Guy, Disney Educational Productions, 1997.

Wormania, Mary Appelhof, Flowerfield Enterprises, 1995.

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Books

Backyard Composting, Your Complete Guide to Recycling Yard Clippings, 9th ed., by Harmonious Technologies, Ojai, California: Harmonious Press, 1992, (707) 823-1999.

Bottle Biology, Dubuque, Iowa: Kendall/Hunt Publishing Company, 1993.

Let It Rot! The Gardener's Guide To Composting, by Stu Campbell, Storey Publishing, 1990.

The Rodale Guide to Composting, by Jerry Minnich, Emmaus, Pennsylvania: Rodale Press, 1979.

Worms Eat Our Garbage, by Mary Appelhof, Kalamazoo, Michigan: Flower Press, 1993.

Equipment

Compost Bins: Harmonious Technologies, P.O. Box 1716, Sebastopol, California 95473, (707) 823-1999.

RPM (Recycled Plastics Marketing), Inc., 2829 152nd Ave., N.E., Redmond, Washington 98052, (425) 867-3200.

Containers: Norseman Plastics,
2296 Kenmore Ave., Buffalo, NY
14207, (800) 267-4391.

Worms: Flowerfield Enterprises,
Kalamazoo, Michigan, (616) 327-
0108.

VermiCo, P.O. Box 1134, Merlin,
Oregon 97532, (541) 476-9626.

Willingham Worm Farms, Rt. #1, Box
241, Butler, Georgia 31006.

Worm Digest, P.O. Box 544, Eugene,
Oregon 97440-9998.

Internet

Ohio Environmental Protection
Agency (Ohio EPA):
www.epa.ohio.gov/

General Information:
www.oldgrowth.org/compost/

Harmonious Technologies:
www.homecompost.com

RotWeb:

- starbase.neosoft.com/~gregg/compost.html
- net.indra.com/~topsoil/Gr4_worm.txt

The Composting Council:
comcouncil@aol.com

New Jersey's Online Yucky Site: Worm
World: www.nj.com/yucky/worm.

Mary Appelhof:
www.wormwoman.com

VermiCo:
www.nwin.com/vermico/email:vermi-co@cdsnet.net

RPM (Recycled Plastics Marketing):
www.rrpm.com

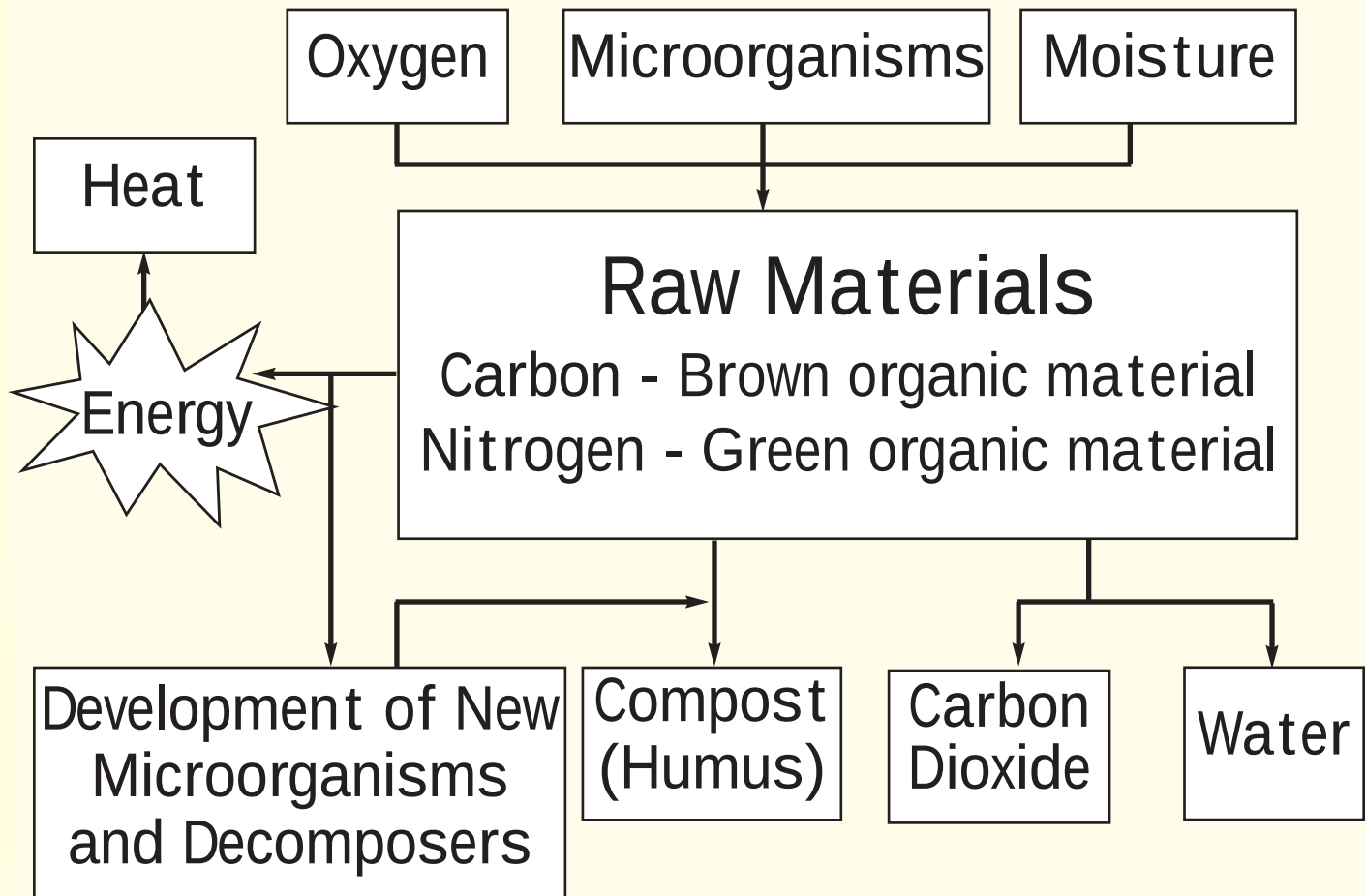
The Master Composter:
www.mastercomposter.com

Publications

Composting, July 7, 1996 and *Yard Waste Management Guidebook for Ohio Communities*, 1992, Ohio Environmental Protection Agency (EPA), 122 S. Front St., P.O. Box 1049, Columbus, Ohio 43215.

Home, Yard, and Garden Facts and Composting: A Citizen's Guide to the Proper Disposal of Leaves and Other Organic Materials, Ohio State University Extension, Horticulture, 2001 Fyffe Court, Columbus, Ohio 43210.

FLOW CHART FOR THE COMPOSTING PROCESS



NATURE'S WAY WITH WASTE

Activity
1

The Great Cycle

Inquiries

- What is nature's garbage?
- How does nature's garbage become part of the food chain?
- In an ecosystem, how is energy transmitted at the bottom of the food chain?
- How is nature's recycling system like composting?
- How is composting like materials recycling?

Content Domain

Reading – Listening/visual literacy

Science – General science, biology

Learning Outcomes

Reading, Grade 4, #14, #17, #18 and Grade 6, #11, #12, #13

Science, Grade 4, #5, #14, #16, #18 and Grade 6, #4, #14, #17

Duration

Part A: 45 minutes, not including pre-test

Part B: 45 minutes

continued next page

Objectives

Students will be able to: (a) identify cycles in nature and compare natural recycling with human-initiated recycling; (b) describe the flow of nutrients and energy at the bottom of the food chain and how this meets the needs of plants and animals, including humans; and (c) identify and interpret vocabulary words critical to the understanding and meaning of composting.

Procedure

PART A

1 You may pre-assess student knowledge of this lesson and its five activities by using the pre- and post-test handout, *Nature's Way With Waste*, found at the end of this activity.

2 Give a copy of the handout, *The Great Cycle*, to each student. Ask students to scan material, paying attention to the words in bold print. Read the story to the class. Discuss what the title means and what the main idea seems to be. To make a comparison, describe how the forest is part of nature's efficient recycling system. Also, point out that the word "cycle" is part of the word "recycle."

3 Have students identify the meaning of the words in bold. Each student can use the 3"x 5" cards to write down a word or word phrase and give its definition. Have students use a dictionary

to find the meaning of the words or have them determine the meanings from the story. (If time is a factor, have each student identify the meaning of only five words or word phrases.)

4 Discussion Questions:

- How is nature's recycling system like composting?
- How is nature's waste like and unlike human waste?
- What are some things that humans make (as waste) that nature does not (paper, plastic, metal)?
- Examine students' own place in the food chain by asking questions such as:
 - Where do you fit into the cycle of life?
 - Where do you fit into nature's cycle?
 - What is your responsibility to care for our Earth?



5 Ask how many of the students know what compost is and if they have a compost pile. Are there any problems with the compost pile? (There is a right way to make compost and that will be revealed in Activity 4, *Meet the YIMBYs*.)

6 Have students keep their 3" x 5" vocabulary cards to use for further assessment.

Procedure

PART B

1 Distribute to each student a copy of the handout, *Cycles*. Have students complete the handout. Be sure to have students look at the pictures and see the direction of the arrows.

2 Organize students into four or six groups to work cooperatively to compare and complete the answers (about 10 minutes).

3 Use the transparency, *Cycles*, to discuss the groups' answers. Discuss the following:

- What is nature's garbage? (as shown in the pictures)
- How does nature's garbage become a part of the food chain?
- Why is it so important that nature's garbage be recycled?
- What part does composting play in the cycle of life? In an ecosystem?
- How is energy transmitted? Explain the flow of nutrients and how these meet the needs of plants and animals.

4 Discuss Question 7 on the handout, *Cycles*. Discuss what is organic material and inorganic material, giving examples of each (dead leaves and hair from a haircut are organic and a computer and a rock are inorganic). Have students explain how systems

for inorganic materials differ from recycling systems for organic materials.

5 Ask students how human activity can affect nature's recycling system and the environment.

Assessment

Several forms are available.

Method A: Give students the pre- and post-test handout.

ANSWERS to *Nature's Way With Waste*:
1. d, 2. c, 3. b, 4. c, 5. d, 6. a, 7. b, 8. b

Method B: Have students draw another type of cycle in nature that includes the transmission of energy (food energy) and label it.

Method C: Give a vocabulary test on the words and concepts from the 3" x 5" cards.

Extension

Write a story about what life in a nearby forest or woods would be like if there were no natural decomposers or scavengers.

NATURE'S WAY WITH WASTE

Materials

3" x 5" cards or **blank slips of paper (24 for each student); transparency of the handout, *Cycles*.**

Handouts

- *Nature's Way With Waste (pre- and post-test)*
- *The Great Cycle*
- *Cycles*

NATURE'S WAY WITH WASTE

Directions: Circle the best answer.

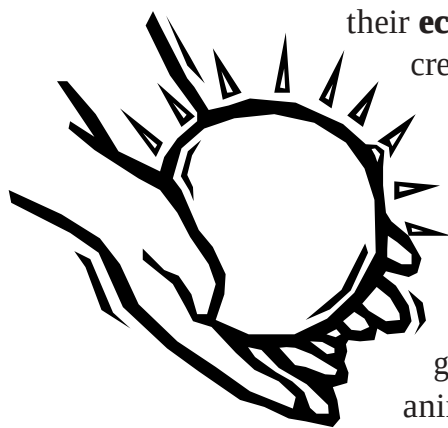
- 1** Which phrase best describes compost?
 - a. a home for decomposers
 - b. nature's recycling system
 - c. soil rich in nutrients
 - d. all of the above
- 2** Which does not describe a food chain?
 - a. scavengers and decomposers working together
 - b. animals eat meat or plants
 - c. recycling a pop can
 - d. flow of energy that is passed on from plants to herbivores to carnivores to decomposers
- 3** Identify what belongs in a recycling bin instead of in a compost pile?
 - a. leaves and grass clippings
 - b. glass jar
 - c. worms
 - d. heat
- 4** What does it mean to biodegrade?
 - a. non-living matter
 - b. garbage and trash that originates in households, commercial establishments or construction and demolition sites
 - c. the cycle of decaying elements or cells of dead plants and animals into similar substances that are absorbed by the environment
 - d. a mixture of mineral and organic material and decomposer organisms, mainly bacteria and fungi
- 5** What helps matter to decay?
 - a. microorganisms
 - b. oxygen, water, heat
 - c. open environment
 - d. all of the above
- 6** What will take the longest to decompose?
 - a. inorganic matter
 - b. organic matter
 - c. old tree branches
 - d. paper
- 7** What is the largest component in our garbage (by weight and volume)?
 - a. glass
 - b. paper
 - c. yard waste
 - d. plastic
- 8** What will happen to a compost pile if there is not enough water or oxygen?
 - a. the odor will be sweet-smelling
 - b. organisms will not survive
 - c. materials will multiply
 - d. organisms will increase in number

Student Handout

THE GREAT CYCLE

EARTH is a beautiful place to live with lovely shades of blue, yellow, red, green and brown. Plants, insects, birds, animals, fish, reptiles and humans all live together on Earth.

All of these creatures are living things, full of **energy** and living in harmony with nature in their **ecosystems**. Each



creature is trying to meet its own **needs** for survival. *The source for all energy is sunlight.* Green plants change sunlight into food energy for animals, and animals convert this food-chemical energy into

kinetic energy for movement and thermal energy for warmth.

Everyday, the natural **cycles** of the seasons (fall to winter, spring to summer), days to nights, seeds to trees, and biodegradation (decomposition) to renewal happens.

There are changes in all ecosystems because the **flow of energy** continues on and on and on...in **food chains**.

Food is a source of energy in food chains. **Food energy** is passed on from plants to herbivores (plant eaters) to carnivores (meat eaters) to **decomposers**. Decomposers use food energy to change **organic** matter, which was once living, into **inorganic** matter, which is non-living matter in the form of nutrients.

And with all of this beauty and energy, there is **WASTE**. All living things produce waste.

Nature's waste includes fallen leaves, tree branches, animal dung, dead plants, dead animals, and grass clippings. Nature's litter!

A large portion of nature's waste is organic or **biodegradable** and therefore can be made into **compost**. Things that can be composted include **food waste** and **yard waste**. There would just be a BIG pile of nature's garbage on the ground if nature's scavengers and decomposers did not dispose of all waste matter.

Large **scavengers**, such as bears, lions and raccoons chew on the skin and bones of dead animals, leaving small pieces behind for the smaller scavengers to eat.

Small scavengers include insects, such as beetles, ants, centipedes, sow bugs and slugs. Two very important small scavengers are earthworms and termites. These small scavengers get rid of waste by recycling it! They pass it through their bodies and leave it behind in the form of **nutrients**, which plants need to grow.



Termites help decomposers break down dead trees. Wood is hard for decomposers to digest because it contains a tough material called cellulose. Cellulose in wood is easier for decomposers to eat after termites have chewed it up or left it in the form of termite dung.

Worms are important scavengers because they digest soil through their bodies as they make tunnels in the soil. They leave behind

Student Handout

worm dung (castings), which is rich in the nutrients plants need to grow.

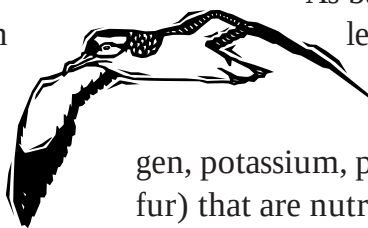
Other small scavengers include aquatic creatures, such as snails and fish, birds such as vultures, crows and seagulls, and mammals, such as rats and mice. These small scavengers also work on breaking down decaying plant and animal matter into tiny pieces for the decomposers. As they consume living or dead matter and metabolize (digest) it, they, too, leave behind excrement, or dung, on which the bacteria feed. Yum, yum.

Tiny microorganisms are part of every food chain and include different types of microscopic **fungi** (such as mushrooms, molds and mildews) and **bacteria**. Decomposers are found everywhere, but are most plentiful in **soil**, where they feed on very tiny pieces of waste matter. Soil is a mixture of mineral, organic material and decomposer organisms, mainly bacteria and fungi. A single table-spoon of good topsoil may contain up to four billion bacteria.



Bacteria are essential to life because as they die and break down into the soil, they are also renewing it with nutrients. *Nutrients are the delicious “vitamins” for plants.* The roots of plants draw them up into their stems or trunks to grow. Soil rich in nutrients is called **humus**. Soil provides nutrients, water and support for plants. The air trapped in soil will provide oxygen to plant roots.

Organic matter from plants affects soil texture and composition.



As bacteria feed on waste, they leave behind *chemical elements* and compounds (carbon, oxygen, hydrogen, nitrogen, potassium, phosphorous, calcium and sulfur) that are nutrients green plants can absorb. The **flow of nutrients** through an ecosystem happens as **energy is transformed and converted** from one state to another.

Life on Earth depends upon nature's recycling system. Together, scavengers and decomposers act as nature's *sanitation* (sewage) crew! They are garbage eaters. They **recycle**. They are recyclers!

And then there is *human waste* – the grass clippings, yard waste, cereal boxes, empty toothpaste tubes, soda pop cans, glass jars, dead refrigerators, old TVs, all of the food waste (those peas and that spinach you won't eat), and the list goes on and on and on!

Although some human waste can easily become part of nature's flow of nutrients, many types of human waste cannot. There is a way that we as human beings can assist **nature's recycling process**. People can recycle nutrients back into the soil. We can turn some of our garbage into soil! We do this by making compost. Remember, compost is the oldest form of recycling!



Student Handout

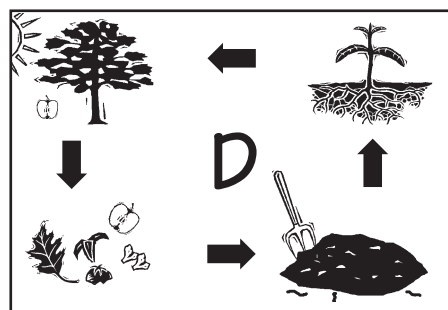
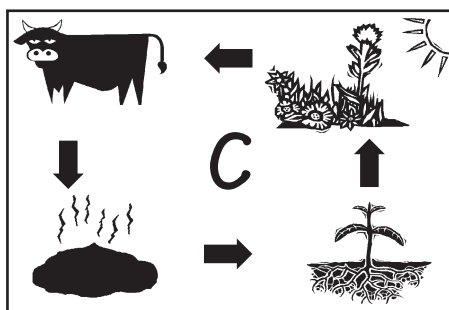
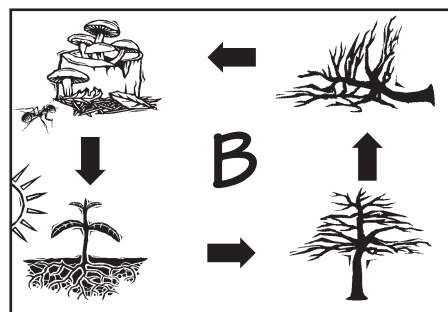
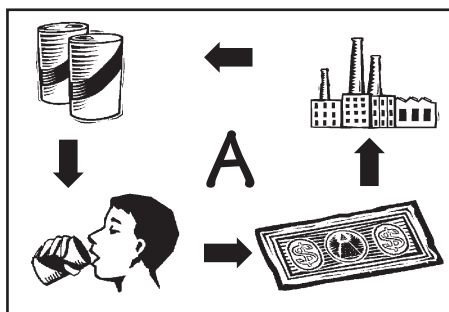
CYCLES

Directions: Use the letters of the picture blocks to answer the following questions. Remember, some questions may have more than one answer.

- 1 What do the arrows represent? _____
- 2 Which blocks show the recycling of plant matter? _____
- 3 Which blocks show the recycling of animal matter? _____
- 4 Which block identifies compost? _____
- 5 Put an X in each block where the decomposers and scavengers will be found.
- 6 In the blocks, circle the pictures that use food energy to produce movement and warmth.
- 7 Which block does not fit with the other three? _____ Why? _____

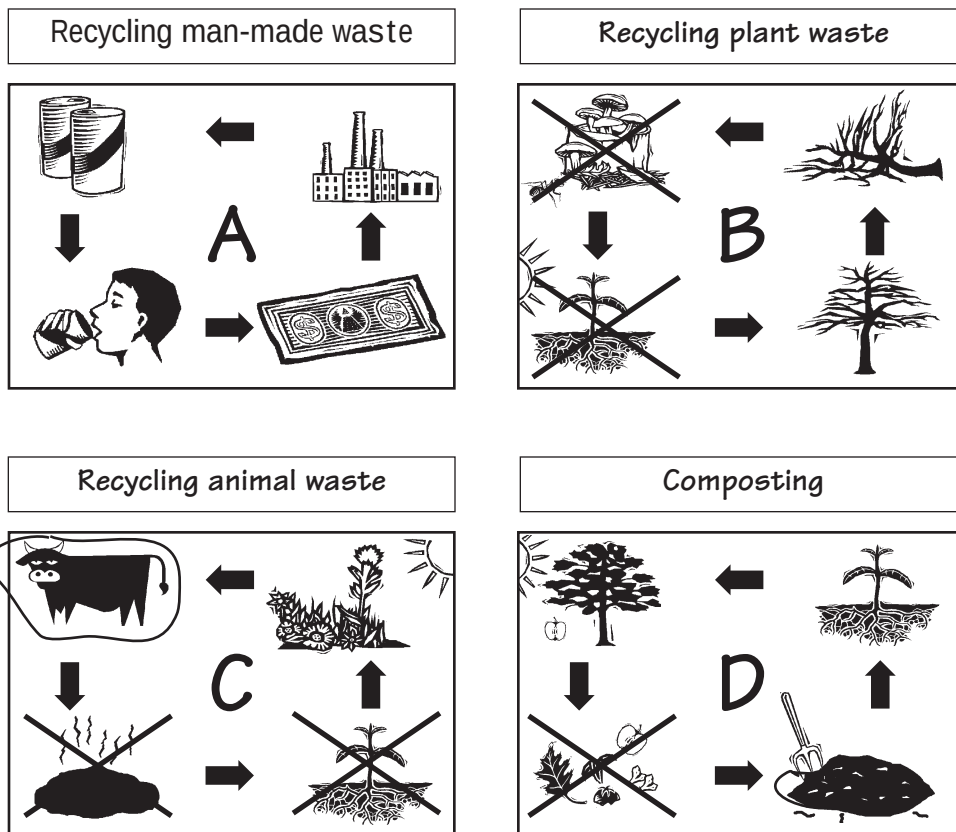
- 8 Pick a block and explain how it represents a food chain. _____

- 9 What is a good title for each of these picture blocks?
 A. _____ B. _____
 C. _____ D. _____



CYCLES - ANSWER KEY

1. energy flow
2. B, D
3. C
4. D
5. and 6. See chart below
7. A
8. answers will vary
9. see sample title above the blocks below





Bio-What? That's Biodegradation!

Objectives

Students will be able to: (a) classify rates of decomposition for their own garbage items; (b) use a simple key to classify decomposition rates; (c) analyze a series of decomposition rates and predict their occurrence in a sequence; (d) identify the relationship between human activity and the environment with regard to packaging; (e) demonstrate an understanding of the basic needs of living things; (f) identify ways in which organisms react to changing environments; (g) distinguish between living and non-living things; (h) identify and interpret vocabulary words; (i) retell a story in their own words; and (j) demonstrate an understanding of the story.

Background Information

Food is packaged in different ways; the **packaging** serves to preserve. Some preservation methods are **natural** or **organic**, such as nature's own packaging (fruit rinds, nutshells, potato skins) and some are **artificial** or **inorganic** (cans, jars, bottles). If packaging material is organic, it can be recycled naturally, by composting.

Artificial packaging, unlike natural packaging, does not degrade easily and must be recycled through a technological process to be used again. Science and technology have enabled artificial packaging to preserve food energy longer than natural packaging. But, the chemical compounds required to provide this function make many consumer products difficult to degrade. Because inorganic packaging materials will not efficiently decompose, they

must be recycled by an artificial system or landfilled. Today's modern landfills make it difficult for organic materials to naturally degrade, so inorganic packaging has little chance of degrading when disposed of in a landfill.

Preparation

One or two weeks prior to conducting this activity, you should put a slice of white bread, a small piece of inorganic material (part of plastic bag, aluminum tab, etc.) and two drops of water into an airtight ziplock plastic bag. This will allow time for mold/fungi to begin to form on the bread to show how decomposition works. Or, have each student individually do this activity – provide each student with his or her own bag. Vary the days making these bags, and show the progression of decomposition, and/or vary the types of organic materi-

Inquiries

- Why do some things take longer to decay than others?
- How does packaging in the natural environment compare with artificial packaging?
- What happens to solid waste, in particular artificial packaging and other inorganic materials, when they are buried in a landfill?

Content Domain

Language Arts – Listening, reading comprehension, writing

Science – General science, biology

Learning Outcomes

Science, Grade 4, #4, #14, #18 and Grade 6, #1, #3

Writing, Grade 4, #1, #2, #7

Duration

Part A: 40 minutes

Part B: 30 minutes

continued next page

NATURE'S WAY WITH WASTE

Materials

One slice of white bread; inorganic materials (pieces of plastic, aluminum can tab, etc.); one ziplock plastic bag; two drops of water (optional - enough slices of white bread, ziplock plastic bags and water for entire class), *The Magic School Bus Meets The Rot Squad* (book)

Handout

- *This Takes How Long to Degrade?*

al (banana peel, peanut, lettuce leaf, orange slice) in the bags. Make a transparency of the handout, *This Takes How Long to Degrade?* and copies for each student.

Procedure

PART A

1 Have students brainstorm and make a list of the contents of their home garbage can.

2 Divide the class into five or six groups. Distribute the handout, *This Takes How Long to Degrade?* Have students make inferences about which solid waste items might correspond with the four classifications.

3 Use a transparency of the handout, *This Takes How Long to Degrade?* to review answers. Also, consider discussing which items from the garbage in the school lunchroom could be added to this chart and where these items could have originated.

ANSWER: *Weeks* – might include pieces of food items or light weight paper; *Months* – might include rags and leaves; *Years* – might include painted fence posts, tree trunks; *Hundreds of Years* – generally includes consumer packaging items, such as cans and bottles.

4 Discuss what happens when these items are put in a landfill. (In a landfill, it takes longer to break down because there is not enough oxygen for aerobic microorganisms to live, and they are more efficient at consuming garbage than anaerobic bacteria.) Identify which items would be good for composting. Discuss how composting reduces the amount of solid waste that is landfilled.

5 Discuss what other factors (other than microbes) help decompose garbage (sunlight, heat, wind, water).

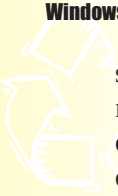
6 Show the class the partially decomposed slice of bread and discuss what happened and why. Why isn't the inorganic item showing signs of decay? Relate this to the time factor and conditions necessary for decomposition to occur. Examine the microorganisms that feed on organic material. (Can they be easily seen?)

7 For first-hand knowledge, give each student a ziplock plastic bag and on different days, have students place their bread (or any organic item) and an inorganic item in the bag. Label each bag with the date of the experiment. Place all the bags where they will not be disturbed and will be observed under the same conditions (temperature, location, etc.). Have students look at the bags at a designated time each day to see what is happening. Chart observations in a daily journal or format of your choice.

8 Discuss the idea of packaging. Does packaging exist in the natural environment? Have students give examples of nature's packaging (corn husk, nut shell, banana peel, cocoon, skins on potatoes, bark on a tree). What is the purpose of nature's packaging?

9 Compare nature's packaging to human-made packaging. Give examples of artificial packaging (soda pop can, plastic wrap, fast food bags). Discuss the different types of organic (paper bag) and inorganic packaging (soda pop can).

Discuss the process of decomposition through exposure to ultra-violet light (sunlight). The time needed to degrade photodegradable bags and some plastics can be as short as three to six weeks in the summer, because the sun is stronger. In the winter, it can take seven to 15 weeks. In our culture, technology produces a wide variety and number of non-degradable materials to meet the needs of con-



sumers. Discuss how science and technology have enabled us to create efficient preservation methods, yet the chemical compounds required to provide this function have made consumer products difficult to degrade.

10 When both artificial and organic materials are disposed in a landfill, they take much longer to degrade than in a natural environment. Solid wastes, such as inorganic packaging, will not efficiently biodegrade or decompose and must either be landfilled or recycled by an artificial system. Discuss how built environments (artificial ecosystems) might be changed to replicate the efficient recycling system of natural ecosystems.

PART B

- 1** Read the story, *The Magic School Bus Meets the Rot Squad* (see Bibliography section). Read slowly enough so students can comprehend the story and look carefully at each picture.
- 2** Have each student respond to the story by identifying key vocabulary words, such as decomposition, rot and recycle.
- 3** Have students demonstrate an understanding of the story by retelling the story in writing, in their own words, by using no more than 100 words.

Assessment

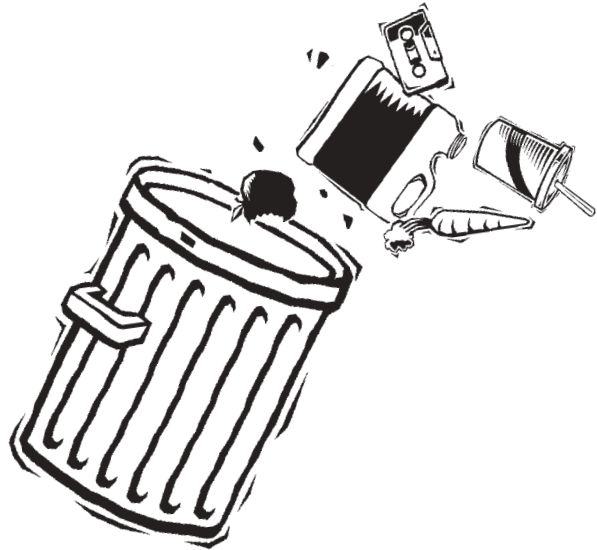
Method A: Have students answer questions 3, 4, 5, 6 and 8 on the handout, *Nature's Way With Waste*, in Activity 1 on p. V-12. These questions relate to this activity. (The test assesses the entire lesson.)

Method B: Student stories written in Part B, Step 3.

Extension

Visit a local grocery store and evaluate the types of packaging used to preserve food based on biodegradability.

Student Handout



THIS TAKES HOW LONG TO DEGRADE?

Directions: In the appropriate boxes below, classify the various items of your garbage according to decomposition time.

	Weeks to Decay	Months to Decay	Years to Decay	Hundreds of Years to Decay



Compost Critters

Objectives

Students will be able to: (a) use a simple key to distinguish between compost critters; (b) identify and compare the dimensions of compost critters in metric measurement; (c) identify and discuss the selection of tools for exploring compost; (d) demonstrate an understanding of the safe use of magnifying glasses and/or microscope and glass slides; (e) demonstrate an understanding of the basic needs of living things; (f) identify ways in which organisms react to changing environments; and (g) sort and identify organisms according to size.

Preparation

Before conducting Part B of this activity, locate an active compost bin and put about 8 cups of fresh compost in a container with a lid to bring to class. Make transparencies of the handouts, *Food Web of the Compost Pile*, *Nature's Sanitation Crew*, *Food Chains* and *Food Chain Within a Compost Pile*. Also, make copies of the first three handouts for each student. Students should have access to scissors, tape or glue, and colored pencils, crayons or colored markers.

Procedure

PART A

- 1** Define compost, using the words organic, organisms, natural and decomposition.
- 2** Give each student a copy of the handout, *Food Web of the Compost Pile*.

Explain to students that this handout not only shows the types of organisms (living) in a compost pile, but also the levels of who eats who. Refer to the key at the bottom of the left hand corner. Discuss the different types of organisms found in a food chain and the level at which they are active.

3 Give students an example of one food chain related to this food web. (A ground beetle eats a mold mite, which eats bacteria, which feeds on organic material.) Make sure students understand the cycle of eaters and of being eaten. Using a transparency of the handout, *Food Chain Within a Compost Pile*, explain this cycle in a simpler form to students.

4 Give each student a copy of the handout, *Food Chains*. Ask students to construct a type of food chain and indicate what the arrows represent (food energy). An example could be: grass grows, cows eat grass, humans drink milk. In the column labeled, "A

NATURE'S WAY WITH WASTE

Inquiry

- How is compost made by tiny organisms?

Content Domain

Language Arts – Vocabulary
Math – Arithmetic
Science – Natural science, biology

Learning Outcomes

Math, Grade 4, #17

Science, Grade 4, #3, #4, #6, #7, #9, #16, #17; and Grade 6, #1, #2, #3, #14, #15

Duration

Part A: 45 minutes

Part B: 45 minutes

Materials

Four magnifying glasses and/or four microscopes and four glass microscope slides and/or petri dishes; rulers with centimeter measurement; scissors; tape or glue; colored pencils, crayons or colored markers; four aluminum pie pans; four forks; one container of fresh compost (approximately 8 cups)

Handouts

- *Food Web of the Compost Pile*
- *Food Chain Within a Compost Pile*
- *Food Chains*
- *Nature's Sanitation Crew*

Compost Food Chain,” have students refer back to the handout, *Food Web of the Compost Pile*, to construct another type of food chain using examples from that handout. An example could be: leaf provides energy to molds and fungi, which provides energy to springtails, which provides energy to centipedes.

5 Have students consider other basic needs that compost critters must have to exist in a compost pile (heat, oxygen, water, bacteria, organic matter). Discuss how heat in a compost pile may destroy some organisms, but create a good environment for others.

6 Discuss the connection human beings have to the compost food chain and its organisms. Identify the various *types of cycles* found in the handout (energy, food, decomposition) and the *place* of compost critters in the cycle of life.

7 Distribute the handout, *Nature's Sanitation Crew*, to each student. Have each student use a ruler with centimeter measurements to compare sizes of the various organisms.

8 Students should choose an organism that interests them, cut the picture out and color it. Students may also draw larger examples of these compost critters to use for display purposes at a later time.

Procedure

PART B

1 Review the transparency, *Food Web of the Compost Pile*, and identify the different types of living organisms in a compost pile. Have each student show the class his/her cut-out colored picture of the organism he/she chose from the handout, *Nature's Sanitation Crew*. Make sure students correlate/evaluate other classmates' measurements, color and place in the food

chain. Ask students to predict which critters might eat other organisms and which might be eaten. Collect cut-out critters and display on a bulletin board.

2 At four locations, place an aluminum pie pan filled with 2 cups of unfinished compost. Do not do this ahead of time, because the microorganisms may crawl or fly around the room.

3 Divide students into four groups. Each group should go to an aluminum pie pan and examine the fresh compost with magnifying glasses and forks. Students may also use microscopes and glass microscope slides and/or petri dishes. All students should be reminded of the safe use of materials in this science activity. Discuss what they are observing (movement, compost composition, texture, etc.). Relate observations back to the handout, *Food Chain Within a Compost Pile*. Students should actually smell, touch and hear (listen to) the compost.

4 Have students return the compost back to its original container.

5 Take about a cup of the fresh compost and put it on top of an overhead projector glass for the class. Observe the organisms as they move about, noting size, movement, etc. and discuss student observations. (Point out that the projector lamp is serving as a heat source.) Immediately following the discussion, return the compost to the container.

6 Ask questions about the problems associated with exploring compost, such as critters get loose, out of their own bigger environment/ecosystem. Discuss the relationship of human activity (making compost) and the environment.

Assessment

Method A: Embedded assessment includes discussion answers and cooperative learning behavior.

Method B: Completing the handout, *Food Chains*, and cutting out the *Nature's Sanitation Crew*.

Method C: Have students describe the instruments necessary to study microorganisms in compost.

Method D: On the handout, *Nature's Way With Waste* on p. V-12, have students answer questions 1, 2, 3, 5 and 8. These questions relate to this activity. (The test assesses the entire lesson.)

Extensions

1 Have each student bring in an old sock and, using various art supplies, make a sock puppet of a compost critter (from the handout, *Nature's Sanitation Crew*) of his/her choice. Students could role-play the chosen “critter” by acting out how it looks, what it eats and who it must avoid in the compost pile.

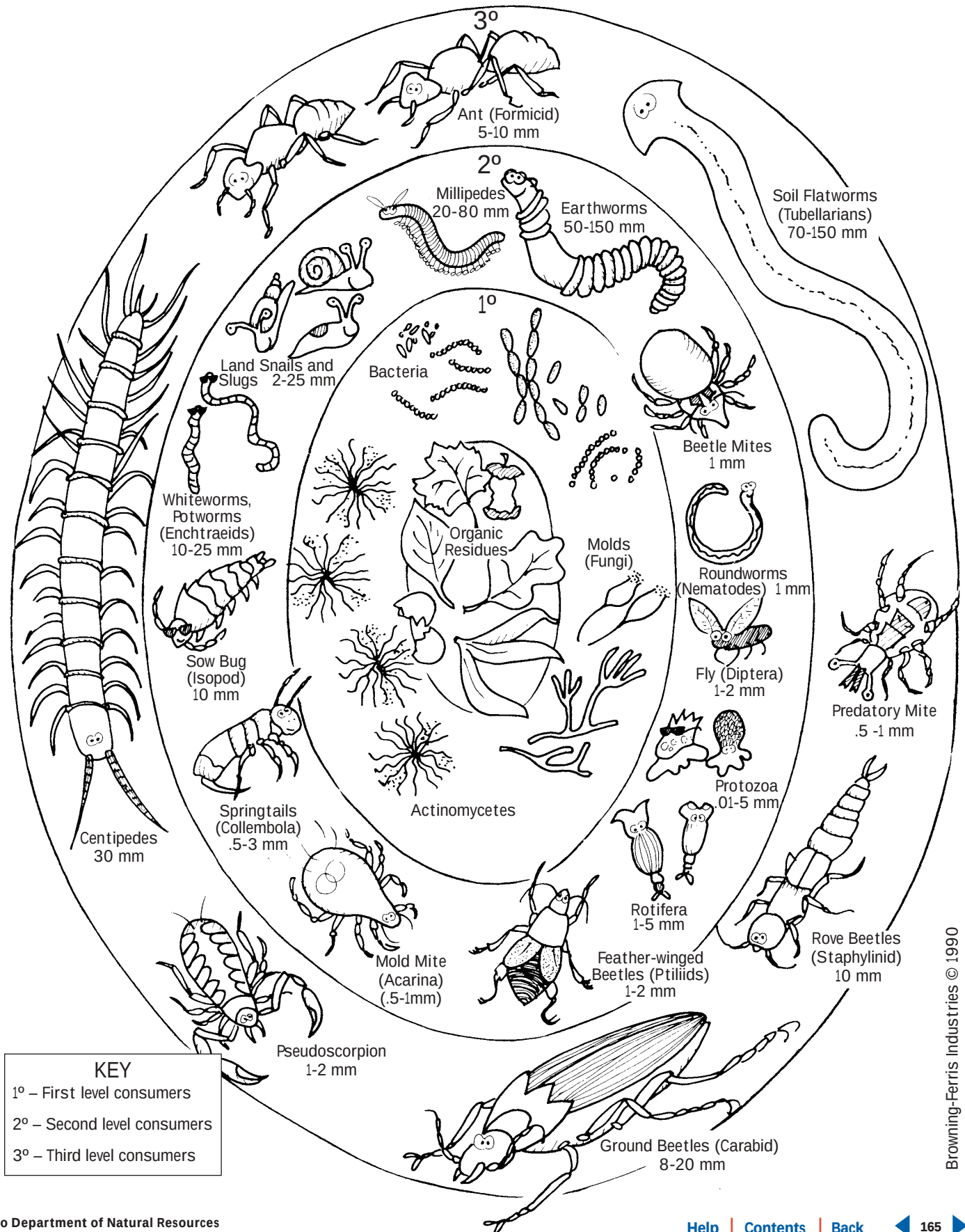
2 Using encyclopedias, research the compost critters. Students could also visit compost-related web sites on the Internet and learn more about compost facilities.

3 Put compost critter names into a hat. Students pick a name and sit in rows of chairs that are classified by various keys (number of legs, size in length, etc.). Ask a variety of questions: Who do you eat? Who eats you?, etc. Students will tag who they eat; thus enacting a food web and the flow of energy.

4 Locate compost piles in your neighborhood and/or city. Are there any large compost sites or facilities nearby?

Student Handout

FOOD WEB OF THE COMPOST PILE



Browning-Ferris Industries © 1990

FOOD CHAIN WITHIN A COMPOST PILE

Flesh eaters/Predators –
centipedes, rove beetles, ants, predatory mites



springtails, mold mites, protozoa



earthworms, beetle mites, sow bugs, flies,
enchtraeids, molds, bacteria

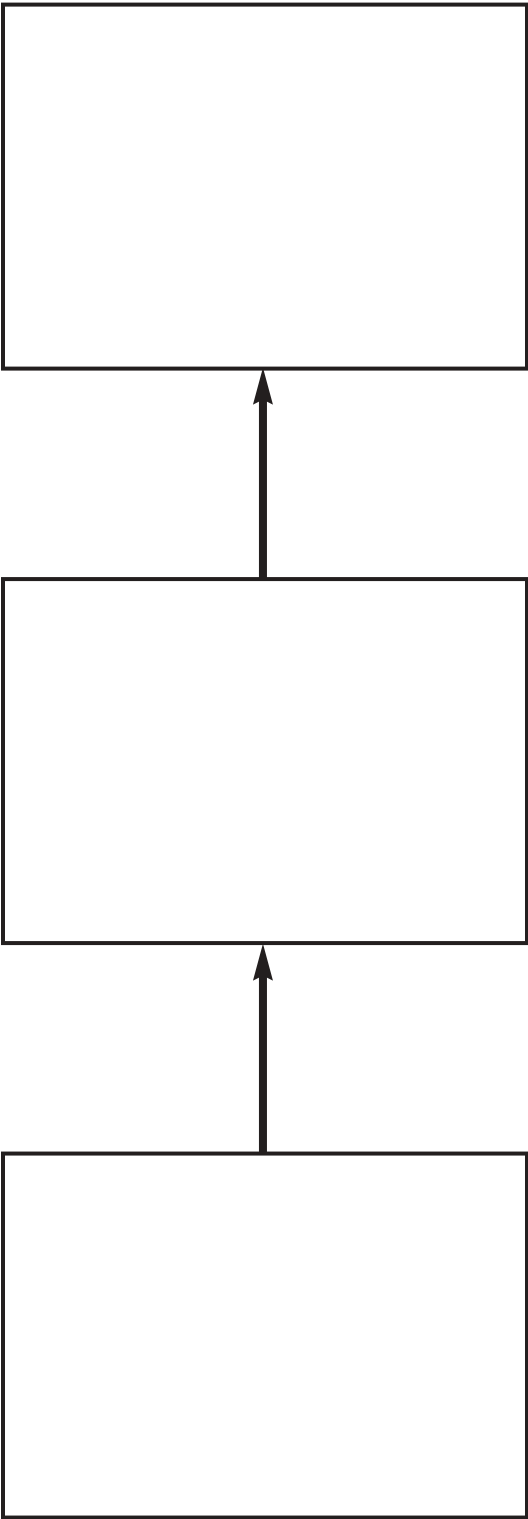


Dead organic matter

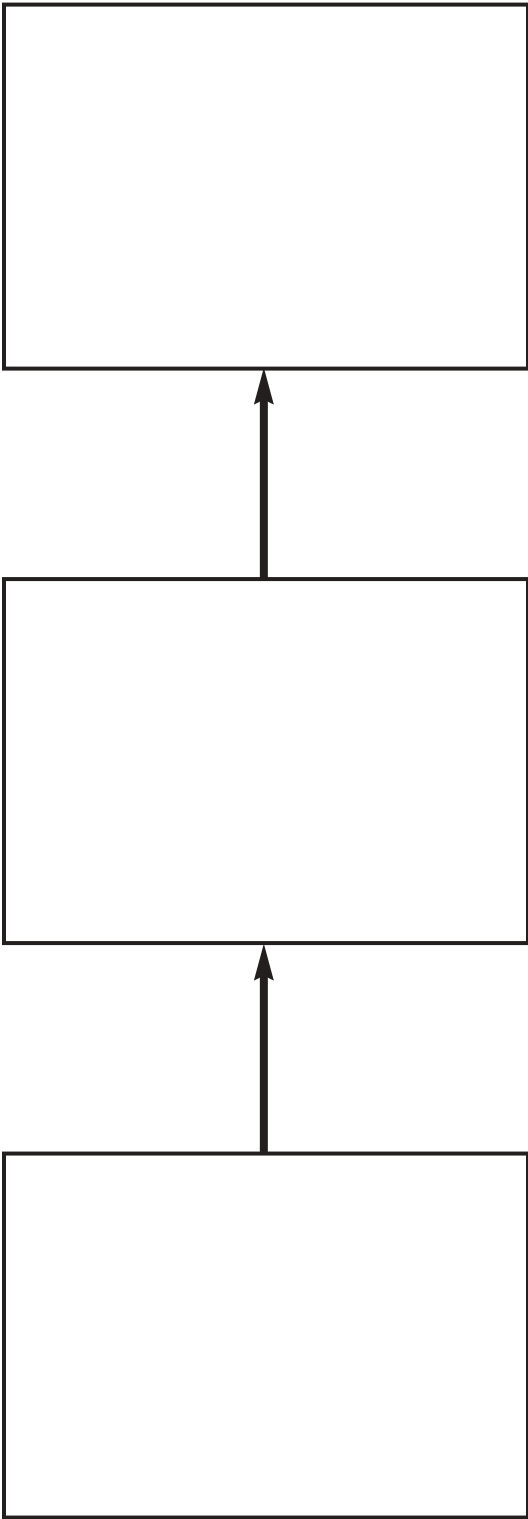
Note: These compost critters are all mixed together and interact with one another, rather than being stacked on top of each other as shown in this diagram.

FOOD CHAINS

A FOOD CHAIN



A COMPOST FOOD CHAIN

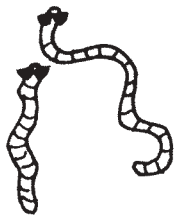


Student Handout

NATURE'S SANITATION CREW

White Worms – Potworms (10-25 mm)

I am a skinny, white worm, also known as a pot worm or an enchtraeid (en kee tray id). I am about an inch long, but I am so thin I look like a frayed piece of thread. I move like an earthworm. In fact, we're related. I don't have red blood like an earthworm. I eat well-decomposed material. You might think of me as one who likes to "finish off" the job of decomposition.



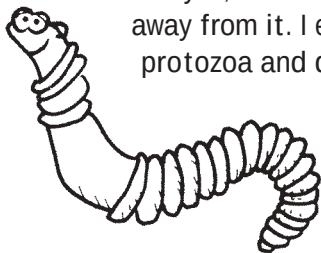
Sow Bug (10 mm)

I am an isopod. I have 10 pairs of legs. I am related to crayfish and lobsters. I breathe with gills, so I must live in a damp, moist place. My ½ inch body is oval and flat, with a series of flattened plates, like my close relative, the roly-poly. However, I can't roll up in a ball. I eat vegetation and leaf litter.



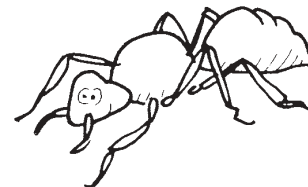
Earthworm (50-150 mm)

I am a long, thin, soft-bodied animal. My body is made up of little rings called segments. I have neither legs nor eyes, but when I sense light, I slither away from it. I eat bacteria, fungi, protozoa and decaying organic matter.



Ant (5-10 mm)

I am an insect with six legs and three body sections: head, thorax and abdomen. I am an important decomposer because I break materials down into smaller particles. I create tunnels, and assemble soil particles into clumps.



Carabid Beetle – Ground Beetle (8-20 mm)

I am an insect with shiny, black, tough wings and I'm about a ½ inch long. I live beneath stones, boards and other moist places. At night, I rapidly pursue my prey, such as slugs, snails and soft insects, like caterpillars. I am a fierce predator.



Fruit Fly (1-2 mm)

I am a small fly. I am sometimes a nuisance. I don't bite, I don't sting and I don't make annoying buzzing noises. I never harm earthworms. People consider me a pest because I sometimes invade compost piles. If it's warm and moist, and fruit and yeast are present, I lay eggs and they hatch. One way to help keep me from being a nuisance is to hide food waste deep in the compost pile. Usually I am present and you don't know it.



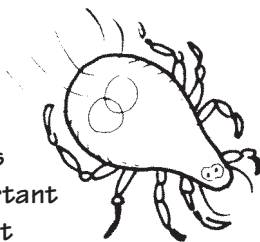
(Worms Eat Our Garbage: Classroom Activities for a Better Environment, Mary Appelhof, © Flower Press, 1993)

Student Handout

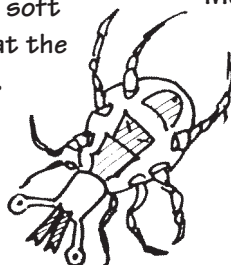
NATURE'S SANITATION CREW, CONTINUED

Mite (.5-1 mm)

I'm tiny. It takes 25 of us to cover an inch long line. My body is so round and fat it's hard to see my eight jointed legs. Thousands of us live in a compost pile. We are important decomposers. Some of us eat plant material, such as mold and soft tissues of leaves. Others eat the manure of other organisms. Some of us can harm earthworms.



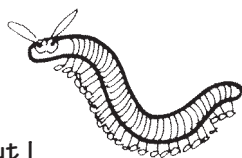
Mold Mite



Predatory Mite

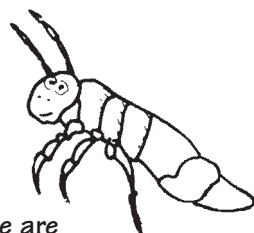
Millipede (20-80 mm)

I have so many legs you would have a hard time counting them. My name means "thousand legs," but I don't have that many. Each segment has two pairs of legs. I'm not fierce, but quite timid. I roll up in a ball to avoid danger. I am a vegetarian and I eat soft, moist, decaying plants. I'm thick-skinned, dark red in color and measure from 1-3 inches long.



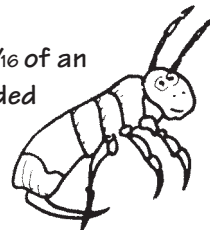
Collembola (.5-3 mm)

I am a close relative of the Springtail, but I don't have the springing tail. I am tiny, often white and less than 1/16 of an inch long. Like the springtails, we are members of a group of animals that are primitive insects. I live with thousands of my companions in compost piles where I eat molds and decaying matter.



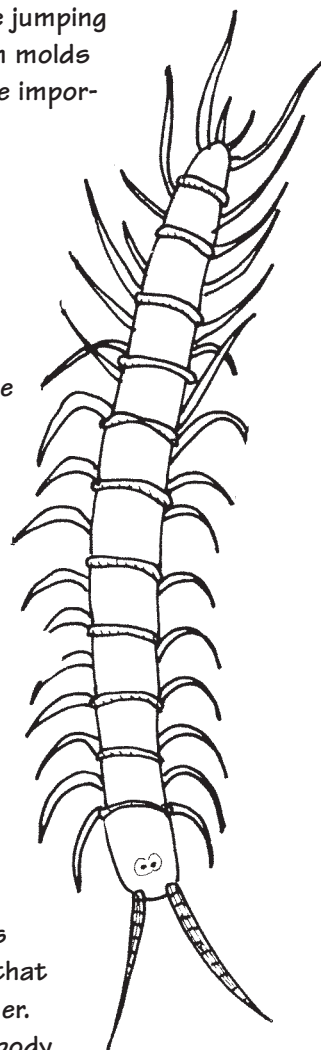
Springtail (.5-3 mm)

I am a tiny, white insect, less than 1/16 of an inch long. I have a pointed prong folded beneath my abdomen. By quickly extending this "spring," I jump high into the air. When thousands of us gather on well-decomposed worm bedding, it looks as if we are jumping all over the place. We feed on molds and decaying matter and are important producers of humus.



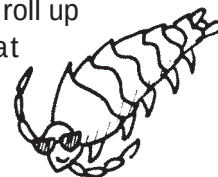
Centipede (30 mm)

I am a fierce hunter! I am known as a predator because I prey on earthworms and eat them. I have a pair of poison claws to help keep my prey from getting away. I move quickly on my many legs. I have only one pair of legs on each of my many (13-173) segments. I am about a 1/2 inch long.



Pill Bug – Roly-Poly

I am an isopod, which means that I have 10 pairs of legs that look very similar to each other. The flattened plates on my body make me look like an armadillo. I am about a 1/2 inch long. I roll up in a ball if I'm disturbed. I eat vegetation and leaf litter.



(Worms Eat Our Garbage, Mary Applehof, © Flower Press, 1993)

NATURE'S WAY WITH WASTE

Activity
4

Meet the YIMBYs

Inquiries

- What is a compost pile?
- What are the components of a compost pile?
- What are efficient ways to compost organic waste?

Content Domain

Language Arts – Oral communication, creative writing

Science – General science, biology

Learning Outcomes

Science, Grade 4, #4, #16, #18 and Grade 6, #1, #3

Duration

45 minutes

Materials

37 4"x 6" index cards; yellow, pink, black, blue, green, brown, red markers; transparencies made from the handouts, *Is It O or Not?* and *Compost Scramble*; jelly beans

Handouts

- *Is It O or Not?*
- *Compost Scramble*

Objectives

Students will work cooperatively in groups to: (a) sort and identify components of a compost pile and construct a model through role-playing activities; (b) use patterns to make generalizations and predictions by identifying missing components in a compost pile; (c) make inferences about nutrient flows and energy transfers; (d) trace the transmission of energy in a small, simple ecosystem and identify the roles of organisms in the energy movement in an ecosystem; (e) demonstrate an understanding of the basic needs of living things; (f) compare and contrast the diverse ways living things meet their needs; and (g) identify and interpret vocabulary words critical to understanding composting. Students will explain how compost is part of nature's nutrient recycling system.

Preparation

Make copies of the handouts, *Is It O or Not?* and *Compost Scramble*.

Write the information from the following chart on 4"x 6" index cards. Use the assigned ink colors to write the phrases listed below:

MARKER COLOR	CARD #	TEXT	MARKER COLOR	CARD #	TEXT
BROWN*	#1	twigs, brush	GREEN*	#4	grass clippings
	#2	pine cones		#5	fruit peelings
	#3	brown leaves		#16	vegetable peelings
	#6	dead animals		#17	coffee grounds, egg shells
	#7	soil		#26	green leaves
	#13	tree branches	BLUE*	#8	rake, shovel or pitchfork
	#14	bark		#22	thermometer
	#15	straw, pine needles			
	#18	dead fish			
	#23	weeds	YELLOW*	#9	oxygen
	#24	peanuts, walnuts, acorns, hickory nuts		#10	water
	#25	sawdust, corncobs		#11	heat
	#27	dung/manure			

MARKER COLOR	CARD #	TEXT
RED*	#12	earthworms
	#19	termites, sow bugs, other decomposers
	#20	bacteria
	#21	fungi
PINK*	#28	cotton rag
	#29	aluminum beverage can
	#30	steel food can
	#31	plastic bottle
	#32	glass bottle
	#33	paper
	#34	cereal box
	#35	newspaper
	#36	meats, fat, oils
BLACK*	#37	finished compost

*BROWN ... brown organic matter
(carbon)

*GREEN green organic matter
(nitrogen)/animal food
and waste

*BLUE tools for making and
observing compost

*RED living organisms, includ-
ing decomposers

*YELLOW ..environmental needs of
the microorganisms who
feed on the compostables

*PINK.....man-made, trash
components

*BLACK.....compost

Write the numbers and words on one side of the card only. The color code will represent the ratio of 3 *browns* (carbon): 1 *green* (nitrogen), which is the necessary mixture for the success of a balanced compost pile.

Remember, too much carbon will cause the pile to decay very slowly and too much nitrogen creates ammonia and bad odors. A proper 3:1 carbon/nitrogen ratio is required.

Procedure

1 Divide the class into four or six groups.

2 Introduce the YIMBY (“Yes, in my back yard,” as distinct from NIMBY, “not in my back yard”) compost components by giving each of the groups the numbered index cards. (Each group will be responsible for determining who will be and do what.) Divide the 37 color-coded cards evenly and randomly. (Can also use the real items, but if artificial items are used with the cards, save time by attaching the card to the item.)

3 Each student will tell the class if he/she is organic or inorganic and in what way he/she will address the needs of plants and animals (as tools or energy sources).

Optional: Use the handout, *Is It O or Not?*, to not only have students identi-

fy what they are in the compost pile, but to expand the list and recognize other items that may or may not be organic and could also be used in the pile.

4 Beginning with card #1, students will individually act out or say what they “are” and then position themselves on the floor at the bottom of the compost pile. The sequence is repeated so that all 37 cards are spoken for and most of the students will be sitting side by side on the floor.

Items To Consider:

- Student #8 (rake, shovel or pitchfork) should *stand* and *mix* students #1-7 and then *mix* students #10-21 in with students #1-7.

- Students #9, 10 and 11 should be added at some point. These components help meet the needs of bacteria and fungi.

- Student #22 (thermometer) should *slip through* students #21-31 and act out a temperature reading of 68° - 77° Fahrenheit. (The temperature in a compost pile may climb to 150°F.)

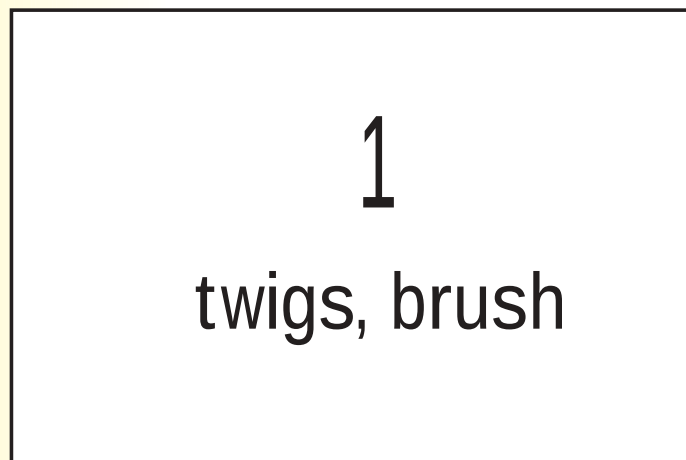
All brown and green cards are sources of food energy for the decomposers. This energy is transformed into movement and heat.

- Students with cards #28-35 are man-made items and the class should discuss whether or not these items should go into the compost pile. These students could be put in a recycling bin and considered later.

40 percent of man's garbage consists of paper products! A small amount of paper products may go into the pile, but students should consider contaminants to nature such as the ink.

- Student (or card) #36 (meats, fats and oils) should never go in a compost pile. Explain the reasons why to the class (spread diseases, attract animals and problems with odor).

Example Card



Note: This card is written with brown marker.

- Student #37 is finished compost. This person should remove his/her shoes and *sit* on top of the pile as he/she reads the definition of compost.

5 When the compost pile has been built, and as students are sitting on the floor, sprinkle some jelly beans (serves as the element nitrogen that may need to be added) on the pile. Then student #8 (the rake) should “*turn*” the pile again. All the students should be moving themselves around in the pile.

6 *Other considerations:* Students should notice the color-coded cards. Remember to explain the 3 B: 1 G ratio (3 browns to 1 green), which will ensure a successful compost pile.

7 Have students complete the handout, *Compost Scramble*.

Assessment

Method A: Make a list of items from the activity, with at least two from each of the following groups: brown, green, red, pink. Scramble the words. Have students make a chart and classify each of the items and explain its purpose in a compost pile.

Collect completed copies of the homework sheet, *Compost Scramble*.

Method B: Embedded assessment of the role-playing. Use a rubric measurement or the rating scale that follows:

Rating Scale

3 = Super

2 = Satisfactory

1 = Needs Improvement

1. Each member of the group handled his/her group role.
2. Each member of the group took turns listening to one another's ideas.
3. Each member of the group

actively engaged in the assigned learning role.

4. Each member of the group applied his/her conflict resolution skills when appropriate to do so.

5. Each member of the group showed respect for one another.

6. Each member of the group made a major contribution to the overall performance.

7. Each member of the group maintained a positive attitude.

Method C: Have students answer questions 1, 3, 5, and 7 on the handout, *Nature's Way With Waste* on p.V-12. These questions relate to this activity. (The test assesses the entire lesson.)

Extensions

1 Students can be asked, ahead of time as homework, to bring in samples of the 37 components of the compost pile. Construct a compost pile outside of the classroom on school grounds after students have learned the procedure.

2 An actual compost bin can be put in the classroom and layered with artificial components. Have the artificial items on a table in the classroom and as students take their numbered cards and before they position themselves on the floor, have them pick their corresponding components from the table and put the components in the bin.

Rotate YIMBY cards so different students play different roles.

3 Create a play utilizing the compost components as characters.

4 Have one student at a time stand in front of the group with the card taped to the back of his/her shirt so that only the group can see the card. Without saying what the word is,

group participants should discuss: What is the definition? How does it help or hurt the pile? The student with the card can attempt to guess the word at any time. The discussion should carry on even after the student correctly guesses the word. Evaluate all student contributions.

5 For homework, have students use their cards to write a short summary, poem or song to answer the following questions: Who am I? What did I do? When did I go in? Where did I fit in (beside what other components)? Why was I important?

6 Make a giant coloring book of a compost pile. Each student could be in charge of a different page.

Student Handout



IS IT O OR NOT?

Directions: Identify the following list by placing a *B* next to each of the organic-carbon items and a *G* next to each of the organic-nitrogen items. *Circle* all the inorganic items.

_____ Twigs, brush	_____ Corncobs, pine needles	_____ Grass
_____ Cotton rag	_____ Cereal box	_____ Paper
_____ Plastic	_____ Coffee grounds, egg shells	_____ Styrofoam package
_____ Pine cones	_____ Weeds, brown leaves	_____ Newspaper
_____ Brown leaves	_____ Dung	_____ Brown paper bag
_____ Wax paper cup/milk carton	_____ Hickory nuts, acorns	_____ Banana peel
_____ Fruit peelings	_____ A piece of wood	_____ Rope
_____ Plastic shopping bag	_____ Sawdust, straw	_____ Bamboo pole
_____ Peanuts, walnuts	_____ Traffic ticket	_____ Plastic six-pack holder
_____ Soil	_____ Green leaves	_____ Vegetable peelings
_____ Tree branches	_____ Aluminum beverage can	_____ Styrofoam package
_____ Disposable diaper	_____ Orange peel	_____ Cigarette butt
_____ Bark	_____ Steel food can	_____ Wool sock

Optional

Directions: Put the capital letter beside the word(s) that it represents.

L = Living organisms T = Tools E = Energy sources

_____ Rake	_____ Bacteria	_____ Shovel
_____ Oxygen	_____ Fungi	_____ Termites and other decomposers
_____ Water	_____ Thermometer	
_____ Heat	_____ Pitchfork	

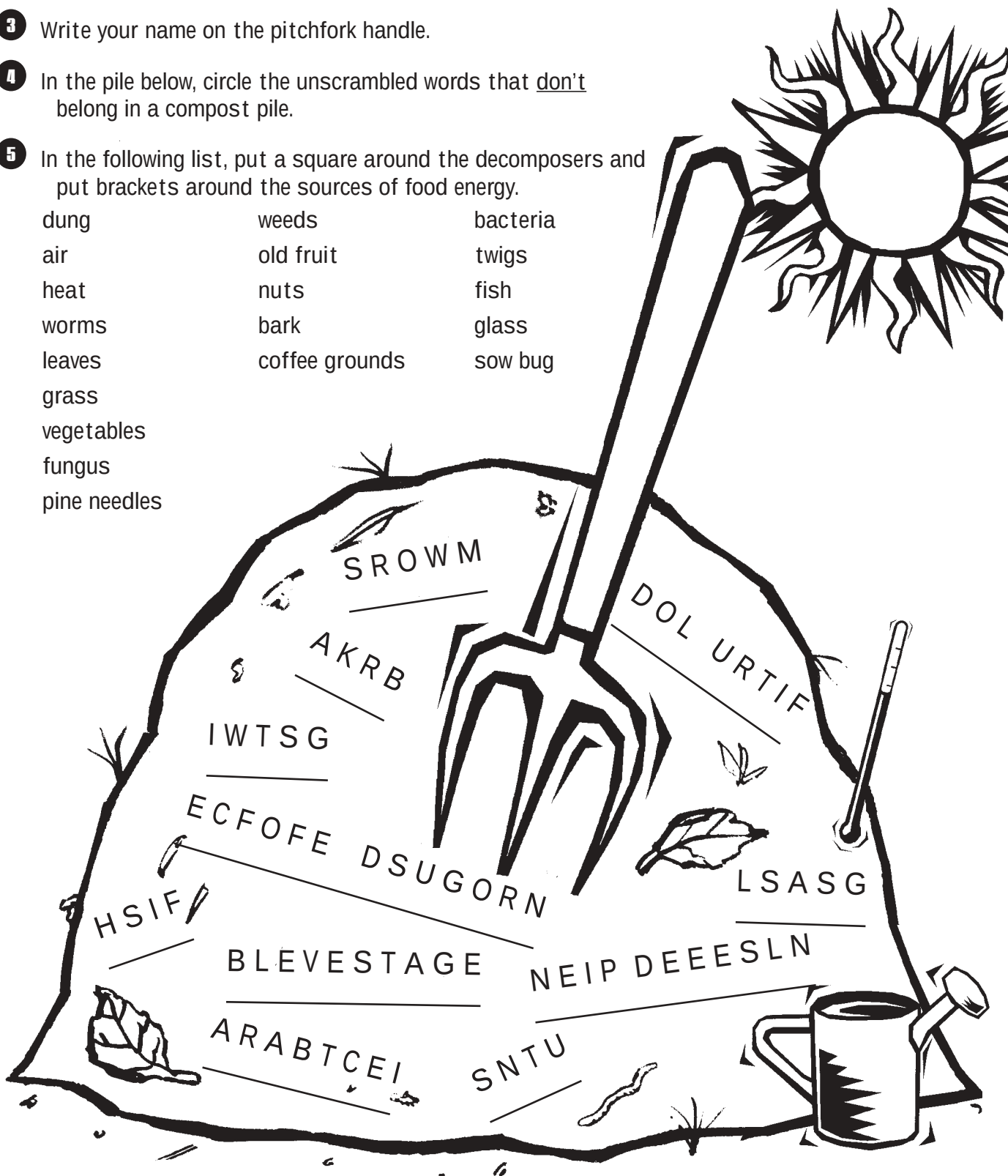
Student Handout

COMPOST SCRAMBLE

Directions:

- 1 Unscramble the words in the compost pile.
- 2 Write the correct word under the scrambled word.
- 3 Write your name on the pitchfork handle.
- 4 In the pile below, circle the unscrambled words that don't belong in a compost pile.
- 5 In the following list, put a square around the decomposers and put brackets around the sources of food energy.

dung	weeds	bacteria
air	old fruit	twigs
heat	nuts	fish
worms	bark	glass
leaves	coffee grounds	sow bug
grass		
vegetables		
fungus		
pine needles		





Compost Jars

Objectives

Students will be able to: (a) make observations and record information about various soil samples, including compost; (b) evaluate a simple procedure to make compost; and (c) describe the value of compost as a soil amendment.

Preparation

PART A

Review background information on composting at the beginning of this lesson.

Collect soil samples and place one cup of each on paper plates; divide the soil samples in this manner:

- Plate #1 = sandy soil
- Plate #2 = clay soil
- Plate #3 = school yard soil
- Plate #4 = potting soil

At four locations, place a soil sample plate and a magnifying glass, a spoon, a popsicle stick, and, if you wish, a rubber glove. Consider using four microscopes and prepare four glass microscope slides of soil samples for the microscope investigation.

Make copies of the handout, *Soil Samples*, for each student.

PART B

Collect enough clean glass jars for each student. Have a tool ready to poke holes in metal lids for the students' jars.

Optional: Have students collect food scraps from the school cafeteria. Keep scraps in a sealed container until the class is ready to begin making their compost jars. (Do not keep waste in the container for more than 24 hours or it will decompose too quickly.)

Procedure

PART A

1 Explain to students that this activity is about soil. Define soil and explain that there are thousands of different types of soil based on mixtures of three basic types – sand, clay and loam. (Silt may or may not be used in your definition.)

2 Divide the class into four groups. Give each student a copy of the handout, *Soil Samples*. Have each group go to one of the soil sample stations. Allow the groups enough time to examine the soil sample and record observations on the handout. The groups should then move from station to station to record their observations of all four soil samples. Make sure students do not write anything in the column under “compost.”

Inquiries

- What are the components of compost?
- How is compost made?
- What is the most efficient way to make compost?

Content Domain

Language Arts – Oral communication, listening/visual literacy, reading content, organization

Math – Arithmetic

Science – Natural science, biology

Learning Outcomes

Science, Grade 4, #2, #6, #7, #9 and Grade 6, #2, #3, #12

Duration

Part A: 30 minutes (not including preparation time)

Part B: 45 minutes or more (depending upon procedure used and compost development time)

Part C: 45 minutes

continued next page

NATURE'S WAY WITH WASTE

Materials

Part A: Soil type samples – sandy soil, clay soil, soil from school yard, potting soil (you may be able to acquire these soil samples from your local Soil and Water Conservation District office); **four magnifying glasses and/or four microscopes and four glass microscope slides; four spoons and four popsicle sticks; four paper plates and/or four petri dishes**

Part B: Four spoons; small thermometer for each group; old newspaper; clean, clear plastic or glass jars (quart-size would be best) **with lids (one for each student); spray misting bottle; tool to poke very small holes in metal lids; rubber gloves; organic wastes** (brought in containers by students), **such as banana peel, orange peel, coffee grinds, sawdust, corn cob, grass clippings, weeds, apple core, egg shells, potato peels, leaves, a piece of paper** (see the list of YIMBY items used in the previous activity, *Meet the YIMBYs*).

Caution: no meat, dairy or fatty items should be used; redworms are optional.

Handouts

- *Soil Samples*
- *Compost Observation Chart* (optional)

3 Engage groups in a classroom discussion to report observations and make comparisons and contrasts of the soil samples. Ask students questions regarding the method of observation – the magnifying glasses and/or the glass microscope slides, as well as the proper usage of the scientific equipment.

4 Collect the completed handouts from students and save them for use in Part C.

PART B

1 Explain to students that they will be making compost. Decide whether every student will make compost the same way, or discuss as a class how students (in groups) could make compost in different ways. Other decisions to make regarding the experiment:

- use a control or no control
- what variables will be used
- type and size of container for compost
- worms or no worms
- types of ingredients (refer to the brown, green, red and yellow factors from the previous activity, *Meet the YIMBYs*)
- what kind of information to chart/observe
- types of hypothesis or hypotheses that will guide interpretations of results

2 To collect compostables, have students request permission to collect food scraps from the school cafeteria. During lunch, students should research types of solid waste in the cafeteria and determine which types would make healthy and safe organic waste for composting. Another option would be to have students bring to class, in containers or some type of secure packaging, organic items from the previously listed materials and/or from the activity, *Meet The YIMBYs*.

3 Distribute to each student, a sheet of newspaper to place on the desk and a plastic or glass jar with a lid.

4 Very small holes need to be punched in the lids for air to enter. Supervise this task closely or punch holes in the lids before distributing the jars.

5 Fill each glass jar about $\frac{1}{4}$ full of soil from your school's or home's backyard. **Do not** use potting soil (chemical additives). You may want to add a little manure to the soil to enhance the growth of microorganisms.

Optional: Add one or two redworms.

6 Add food scraps until the jar is half full; **do not** add meat, dairy or fatty/oily foods.

Optional: You may want to chop the food and yard wastes into small pieces with a blender or food processor. Smaller pieces will hasten the decomposition of the organic waste.

7 Place a 1-inch layer of soil, then add a 2-inch layer of organic waste and a few drops of water to the jar to keep everything damp. Don't add too much water; the compost should be moist, but not soggy. Use a misting bottle to moisten the soil. Then add a $\frac{1}{2}$ -inch layer of newspaper.

8 Place a 1-inch layer of soil or compost on top of the completed pile.

9 Add additional water as needed to make the pile moist, but not soggy. It should feel like a damp sponge.

10 Place a thermometer in the middle of some of the compost jars. See the diagram on p. V-35.

11 Put lids on the jars. Place the completed compost jars in an easily accessible area in the classroom. Do not put them in direct sunlight, unless this is a variable, because the worms may die.

12 The contents of the compost jar should be turned once a week. This may be done with a fork or by gently shaking the jar.

13 Each student should record the initial odor, temperature, height and weight of the compost. Students should record observations once or twice a week, or at other designated times. The handout, *Compost Observation Chart*, can be used to record data. Allow enough time to pass (up to a few months) for compost to develop.

14 Have students compare their observations and findings. If the experimental approach was used, students should synthesize the information and evaluate the decomposition/composting process to see if it confirmed their hypotheses.

PART C

1 Return the nearly completed handout, *Soil Samples*, to each student (from Part A).

2 Now have students observe the compost they made and record data in the middle column for compost.

Have students compare and contrast their findings with the other four soil types.

3 Ask students how compost would be beneficial if it was added to the other soil types.

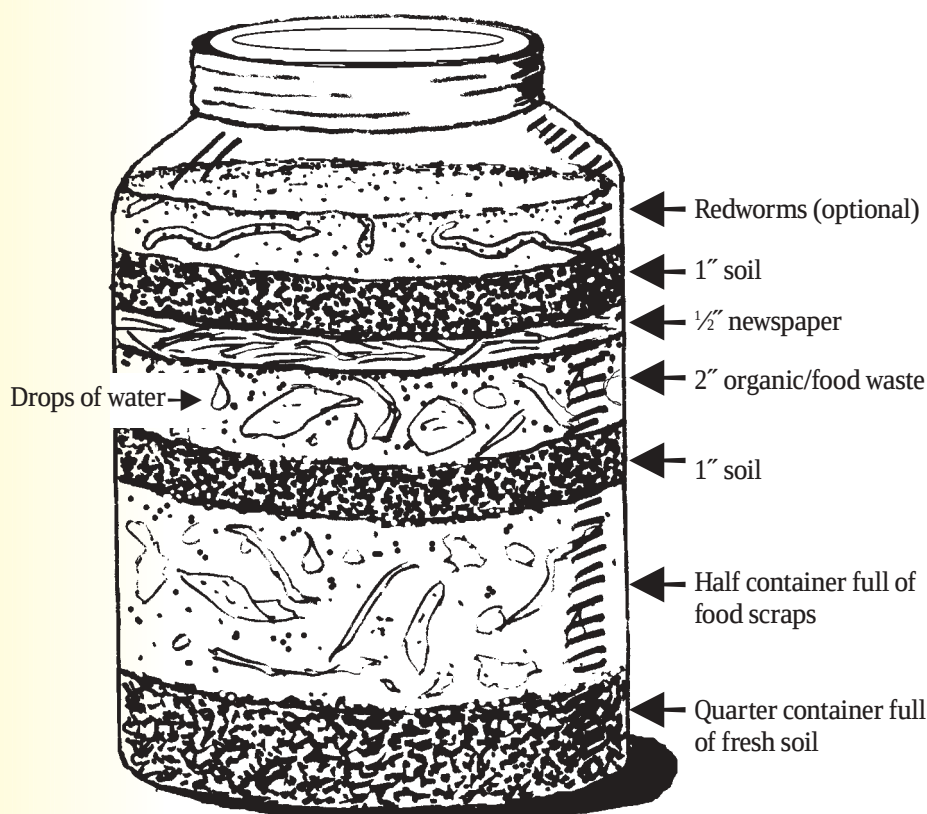
Assessment

1 Assessment may include evaluation of completed handouts. Have each student evaluate the compost jar procedure and write up safety procedures, equipment use and suggestions for improving the activity or experiment.

2 Students could also make a scrapbook on composting. Evaluate with a rubric.

3 Have students answer questions 3, 5, 6, and 8 on the handout, *Nature's Way With Waste* on p. V-12 from Activity 1. These questions relate to this activity. (The test assesses the entire lesson.)

Diagram of Compost Jars (Completed)



If you conducted the entire lesson, administer the entire handout. Return the handout to students and discuss.

Extensions

1 Plant seeds in soil samples from the activity, with and without compost, and compare growth rates.

2 Conduct a vermicomposting activity (see Background Information section). Construct a worm bin for the classroom and nurture it throughout the school year. (Suggestions for ordering worms for classroom compost projects are found in the Bibliography section, under Educator Information.) Students could also create a compost center equipped with plastic gloves, thermometer, paper towels, magnifying glasses, storybooks of compost critters, etc.

3 Have students conduct interviews with the following: a farmer – to find out what he/she does with his/her dead livestock; a senior citizen – regarding his/her experience with recycling, compost, garbage; and a garden store/nursery owner. Interviews could be done with a tape recorder. Students could then write a report or role-play the characters for the class.

4 Visit a compost facility or a municipal yard waste drop-off site. What community efforts have been established to compost organic materials?

5 Research the types of solid waste found in the school's cafeteria. Examine the cafeteria's organic food scraps, as well as the school's organic waste – grass clippings, leaves, etc. Which of these wastes are considered healthy and safe organic waste? Could these items be used to begin a classroom compost pile project? How about a school compost pile? Design a compost pile for your school's organic wastes.

Student Handout

SOIL SAMPLES

There are more than 70,000 different types of soil in North America. A classification system is needed to distinguish the types.

Soil can be classified by texture (feel).

- Soils that are clay-like are smooth, sticky and dense. They hold water tightly, making it less available to plants.
- Soils that are sandy are very gritty, loose and crumbly. They hold little water for plants.
- Soils that are loamy are mixtures of the soils above. They are loose, crumbly and hold water well.

Soil can also be classified by color.

- Dark – black, dark gray or dark brown
- Medium – brown to yellow brown
- Light – pale brown to yellow

The more organic material in the soil, the darker the color of the soil. Generally, the darker the soil, the more easily water sinks in and the better it is for growing plants.

Directions: Examine the soil samples. Complete the following chart and questions.

	1 Sandy Soil	2 Clay-like Soil	3 School Soil	4 Potting Soil	5 Compost
Location Found					
Color					
Smell					
Particle Size					
Texture					
Prediction for growing plants G=Good, F=Fair, P=Poor					
Furthur Observations					

Directions: Answer the following questions on the back of this handout.

- In what ways are these soil types alike?
- In what ways are these soil types different?

Student Handout



COMPOST OBSERVATION CHART

[illegible]

SEPARATION MANIA

Environmental Studies Learning Concept

Technology increases material prosperity by increasing human's efficiency in completing tasks and making products. It also increases a society's chance of changing the natural environment in negative ways, including land degradation through the acquisition of natural resources and the generation of pollution. Therefore, technological efficiency, from an environmental (and sometimes economic) perspective, is based on completing more tasks or making more products with fewer natural resources, less energy and less pollution. Appropriate technology does this by meeting human needs with minimal long-term damage to the environment and maximum social and economic benefits to its users.

Solid waste management, including recycling, requires the use of technology. Recycling is an appropriate technology – it generally reduces land space consumption, energy and resources; it reduces the generation of pollution; and it creates more jobs than disposal programs. One of the most complex challenges in recycling and waste collection is to efficiently collect, separate and prepare materials for reintroduction into the manufacturing process. Simple and complex machines can be integrated into processes to make recycling more efficient. Technology can be applied, which will change the way products are made so they can be more easily recycled. Solid waste collection and disposal processes rely on technologies to improve collection efficiency and reduce the volume of solid waste.

Vocabulary

appropriate technology – tools and processes that meet human needs with minimal long-term damage to the environment and maximum social and economic benefits to the users

commingle – to mingle together; intermix in a single container trash items made from different materials

contamination – being made impure through contact or addition of another substance

ferrous metal – metal containing, or derived from, iron

manual – physically worked by human hands without electricity or other power source

materials recovery facility (MRF) – facility for separating and preparing solid waste products and materials for recycling

mechanical – produced or operated by machinery (simple and/or complex machines)

natural resources – things from nature, such as ores, plants, animals; the source of all consumer products made of glass, steel, aluminum, paper, plastic, etc.

paperboard – a relatively stiff, heavy material, thicker than paper, made from paper pulp; commonly used as container material

recycling – the act of collecting and separating materials and products from the solid waste stream and reusing them as raw materials in manufacturing processes

technology – all the tools and processes, including knowledge, used to extract resources from the environment and provide goods and services

Overview - SEPARATION MANIA



Activity 1: Separation Mania

Description

Students simulate the operation of recycling technology at a materials recovery facility (MRF) by constructing a classroom model to separate “recyclable” objects with simple machines along a moving conveyor. They *observe* the objects carefully and complete a handout to *describe* the differences and similarities of the physical characteristics of the items. They *cooperate in groups* to test the mini-MRF and they *analyze* the results to redesign the process. Students perform another trial run and *evaluate* it for accuracy and efficiency. They *compare* the two attempts and make recommendations for further improvements.

Ohio Proficiency Test Learning Outcomes

Grade 4, Science #2 – Select instruments, make observations and/or organize observations of an event, object or organism.

Grade 4, Science #6 – Evaluate a simple procedure to carry out an exploration.

Grade 4, Science #12 – Explain and/or predict the motion of objects and/or describe the effects of some objects on other objects.

Grade 6, Science #7 – Predict the influence of the motion of some objects on other objects.

Summary

This lesson includes one activity.

Background Information

Recycling is a **technology** that returns old materials or trash to the manufacturing process. Using recycled materials to make new products consumes fewer **natural resources** and reduces pollution. Recycling is an **appropriate technology** because it promotes conservation and lessens environmental degradation.

Recycling is achieved when materials are sorted and separated from the solid waste stream, and the processed recyclables are used to manufacture new products. To meet the specifications of manufacturers,

recycling businesses rely on people and technology to clean, sort and prepare the recycled materials. The process of separating and preparing materials for manufacturing adds costs to recycling efforts. Therefore, the success of recycling is based, in part, on how efficiently different materials (glass, paper, plastic, etc.) can be collected and separated from each other.

Separation generally begins at the source of waste generation, such as residences and businesses where recyclables are separated by hand from other waste materials. These materials may then be collected through curb-

side pickup, drop-off boxes or buy-back centers. Waste generators may, or may not, separate specific recyclable items from each other. When recyclable items are collected together or **commingled**, further separation of these items takes place at a recycling center or **materials recovery facility (MRF)**. Some MRF facilities receive mixed waste, which requires them to separate recyclables from all types of trash and garbage, others receive only commingled recyclables for separation.

At a MRF (pronounced “murf”), materials run along conveyor belts and are both manually and mechani-

Background Information, continued

cally separated. Sorting methods differ from material to material. Paper and cardboard are often sorted manually. Commingled glass, aluminum, steel and plastic are often sorted using a combination of **manual** and **mechanical** techniques.

As the commingled mixture moves along the conveyor line, the **ferrous metal** (steel) is pulled out with magnets and loaded into a container to be baled or shredded and then shipped to a manufacturer. The plastic may be sorted by a vacuum or blower and/or sorted by hand to separate the plastic into types such as PETE (#1 plastics, including soft drink, juice and water bottles) and HDPE (#2 plastics, including milk jugs and detergent bottles). The plastic is then compacted, baled and sent to a manufacturer. Glass is manually separated by color, crushed and sent to a manufacturer. Aluminum, which moves down the line and eventually falls off the end into a container, is also compacted and sent to a manufacturer.

Along the entire sorting line, workers must pay close attention to

ensure that materials are accurately sorted. Accurate sorting methods are crucial to the financial stability of recycling centers. Manufacturers rely on recycling centers to provide uncontaminated material. If the material received from a recycling center is not pure, the manufacturer will either refuse it or demand a price reduction, depending upon the level of **contamination**. For example, recycled paper manufacturers who buy newspaper may accept paper bales that also include **paperboard**, but will pay the recycling center less for those “contaminated” bales. Once manufacturers receive the materials, they may conduct additional sorting and cleaning operations for quality control purposes.

After new products are made from recyclable materials, they enter the market system. In order to “close the loop,” consumers must purchase recycled-content products. Unless consumers make these environmentally-friendly choices, there is no incentive to begin the process of sorting and separating recyclable materials.

Bibliography and Additional Resources

Student Resources

How the Environment Works, by Preston Gralla, Ziff-Davis Press, 1994.

25 Simple Things Kids Can do to Save Energy, The Earth Works Group, 1992.

Internet

Ohio Energy Project Web Site:
www.ohioenergy.org

Media

Bill Nye the Science Guy – Biodiversity and Garbage, Disney Educational Productions. Both videos are 26 minutes. To order: (800) 295-5010.

Educator Information

Earth Cycles Curriculum Supplement, Ohio Energy Project and *Cycles for Science*, Steel Recycling Institute. Ohio Energy Project, (614) 785-1717.

Missouri Polymer Ambassador Activities, Mary E. Harris, 1996, (314) 993-4040.



Separation Mania

Objectives

Students will be able to: (a) explain how technology and principles of physical science can be applied to sort and separate materials with different physical characteristics; and (b) explain the importance of technological processes for recycling.

Preparation

Arrange the room as follows. Set up a row of desks, 10 feet or longer, in the center of the room (no chairs). Set up six student group locations at desks with chairs around them.

Place the items for each group (see below) in a brown paper grocery bag. With a permanent marker, write the name of the group on its corresponding bag.

Conveyor Group – several sections of newspaper, masking tape, paper tubes and box

Aluminum Group – two pieces of construction paper, two straws, two bar magnets, a cookie sheet, two balloons and a container marked ALUMINUM

Steel Group – two pieces of construction paper, two straws, two bar magnets, a cookie sheet, two balloons and a container marked STEEL

Paper Group – two pieces of construction paper, two straws, two bar magnets, a cookie sheet, two balloons, a container marked PAPER and a container marked CARDBOARD

Plastic Group – two pieces of construction paper, two straws, two bar magnets, a cookie sheet, two balloons, a container marked PLASTIC # 1 and a container marked PLASTIC #2

Glass Group – two pieces of construction paper, two straws, two bar magnets, a cookie sheet, two balloons, a container marked CLEAR GLASS, a container marked GREEN GLASS and a container marked BROWN GLASS

Procedure

1 Divide the class into six groups. Give each group a small bag, as previously prepared, with two or three samples of each material (steel paper clips, aluminum tabs, newspaper pieces, cardboard pieces, #1 plastic pieces, #2 plastic pieces, clear, green and brown floral vase marbles). Give each student in each group the handout, *Similar and Different?*, to complete by observing the materials and discussing potential answers with their groups. Discuss the answers as a class.

2 Discuss recycling concepts from the background information with the

SEPARATION MANIA

Inquiries

- What types of machines are part of recycling technology?
- How can different solid waste materials be separated mechanically to prepare them for recycling?

Content Domain

Science – General science, physical science

Learning Outcomes

Science, Grade 4, #2, #6, #12 and Grade 6, #7

Duration

Two 50-minute class periods

Materials

Sample items for conveyor belt: newspaper (no comics or sports); **masking tape;** **several empty paper towel** or **wrapping paper tubes;** **scissors,** **desks lined up in a row** (10' or longer); **long rectangular tray or box the width of the paper conveyor** (about 27" maximum) to collect the items that drop off the end of the belt

Sample items for five sorting machines: **10 pieces** (two per group) **of heavy construction paper;** **10 straws** (two per group – do not share or reuse); **10 bar magnets** (two per group); **five** (one per group) **pieces of cardboard** or other rigid material (about 27" long by 12" wide) that can be cut with scissors; **nine large-mouthed containers** (i.e. whip cream containers); **numbers per group, 10 balloons** (two per group)

continued next page

SEPARATION MANIA

Materials, continued

Containers for each group of sorting machine items: **six brown paper grocery bags, black permanent marker**

Tools to make the sorting machines: **six scissors** and **tape dispensers** (one each per group); *Optional:* **extra construction paper** and **cardboard**

Items to represent commingled recyclable materials: **50 aluminum soft drink tabs; 50 large steel paper clips; 100 pieces of newspaper** ($\frac{1}{2}$ " squares); **50 pieces of cardboard** (about 4" squares); **plastic** (100 pieces) **including 50-2" circles cut from plastic (#1) soda bottles and 50-2" circles cut from plastic (#2) milk jugs; glass** (100 pieces) **including 40 clear flat floral marbles, 30 green flat floral marbles and 30 brown flat floral marbles** (Make sure the floral marbles are the flat oval variety; they may be obtained at craft or garden supply centers.); **bag or other container** to store all the recycled materials together

Before all of the items go in the bag, make six group collections of two or three samples of each material (**steel paper clips, aluminum tabs, scrap paper pieces, cardboard pieces, #1 plastic pieces, #2 plastic pieces, and clear, green and brown floral vase marbles**) and put them in six small ziplock bags or other containers. Place the remaining quantities in the large bag and mix them up.

Handouts

- *Similar and Different?*
- *Mini-MRF Evaluation*

class to explain the importance of the exercise just completed. For example, products that end up in the waste stream are made from materials that have different physical properties to serve different purposes. In order to recycle these materials, they must be separated by material. Explain to the class they will be making a model of a materials recovery facility – a mini-MRF – which includes a combination of separate technologies and processes for sorting materials.

3 Designate each of the six groups of the mini-MRF as one of the following: Conveyor Belt, Aluminum Sorting Technology, Steel Sorting Technology, Paper Sorting Technology, Plastic Sorting Technology and Glass Sorting Technology. Give the conveyor group the materials they need to make a conveyor belt. Give each material group its bag of supplies, which will be used to create a sorting technique and simple machine.

The goal of each of the five material groups is to make a technology, from the sorting machine supplies in their bags, that will sort out the group's specific material from all of the others commingled together on the conveyor belt. Each group may use any number of items from its bag.

The conveyor belt group's goal is to make a moving conveyor belt using the tables and its assortment of supplies, and decide the order of each of the sorting technologies along the conveyor belt (i.e. where students stand, etc.).

4 Allow 20 minutes for each group to discuss how it will create a machine to perform its function within the MRF. Share the mini-MRF rules (and hints, if needed) with the groups.

RULES

- Only two students from each material group can operate the sorting technology, (either together or one on each side) depending upon how they use the technology. Other students in

the group can stand nearby and make additional manual sorts by hand, if needed. Four students can operate the conveyor belt. Other members of the groups should observe standing close to their representatives.

- Once an item (or items) has been moved off or lifted off the conveyor, it may then be manually handled to place it in the container for that specific material. Otherwise, students may not touch any of the materials on the conveyor belt.
- Once a material is moved or lifted off the conveyor, it cannot be put back on the belt, even if it is not the correct material for that group. Students cannot pick up an item once it has fallen. Tell students it is better to collect a "contaminating" material in their container than to let it fall to the floor.

HINTS

Do not make any suggestions to students unless they are unable to think of ideas after a certain amount of time.

- Magnets taped to cardboard will pull off steel.
- Construction paper or straws can generate a force of air to remove items by weight.
- Cardboard can be used to make size sorters.
- Balloons can be used to generate static electricity to pick up light (newspaper) objects.
- Scoops can be made of cardboard and/or straws to guide materials off the line.
- 5** Begin assembling the mini-MRF by having the Conveyor Belt group construct the belt and designate the order of the sorting groups on the belt. Place a box on the floor at the end of the belt. Have all students assemble at the belt in their designated places.
- 6** Tell the Conveyor Belt group to start moving the conveyor belt. In ran-



dom amounts, deposit handfuls of the commingled material onto the conveyor belt. Start at the beginning of the line and continue as the belt begins to move and all materials are used. Each group must attempt to separate its designated material as it moves past. After all of the materials have traveled along the conveyor belt, have students return to their seats with the materials they collected in their group's containers. Results will vary; containers may contain more than just designated materials, or the group(s) may not have successfully collected any materials.

7 As a class, have students record the results of the trial run on the handout, *Mini-MRF Evaluation*, by completing questions 1-3. Discuss the answers.

Question 2 involves counting all of the materials in all of the sorts, including how many materials fell to the floor and how many were left at the end of the conveyor belt in the box. If one type of material is most prominent at the end, then the last stage of dropping off the belt could be considered a successful classification technique. When discussing Question 3, ask how many manual sorts had to be made compared to mechanical sorts.

8 Have each student individually answer Question 4 on the handout, *Mini-MRF Evaluation*, to assess each student's understanding of the concepts in the activity.

9 After students share their answers to Question 4 with their groups, have each group redesign the entire MRF so that it will operate more efficiently. Each group should be prepared to explain in hypothesis fashion why they think their modifications will lead to better results.

10 After each group presents their design, have the class select which design it believes is best. Conduct another trial run using that design and compare the results with those from the first trial.

Assessment

- 1** Embedded assessment in Step 8.
- 2** Ask students the following: How might the comparisons on the handout, *Similar and Different*, help to make a sorting machine? What information about the physical properties of materials would be useful to create a MRF? How can the success of a MRF be evaluated?

Extensions

- 1** Have students design another MRF model, but allow them to bring in and use additional materials of their choice to make new technologies. For example, students could experiment with flotation devices, fans or simple machines, such as inclined planes, pulleys, wheel and axle, etc.
- 2** Arrange a tour of a materials recovery facility. Identify the simple machines and manual techniques used in the operation and compare with those designed by the class.

Student Handout

SIMILAR AND DIFFERENT

Directions: Explain how the following pairs of materials are similar or different based on their physical qualities (color, strength, weight, etc.). Observe and handle examples of each material as you complete your answers.

PLASTIC and PAPER

Similar because: _____

Different because: _____

GLASS and METAL

Similar because: _____

Different because: _____

PAPER and CARDBOARD

Similar because: _____

Different because: _____

CLEAR GLASS and GREEN GLASS

Similar because: _____

Different because: _____

PLASTIC and GLASS

Similar because: _____

Different because: _____

#1 PLASTIC and #2 PLASTIC

Similar because: _____

Different because: _____

ALUMINUM and STEEL

Similar because: _____

Different because: _____

Student Handout



MINI-MRF EVALUATION

1 What type of force or motion did your group use to sort its material?

2 How well did your group succeed in separating only its material from the other materials?
(Decide what type of measurements can be made in order to decide how well your group succeeded.)

3 Which group had the best results? Why?

4 How could the entire MRF be improved for better results?
(Explain on back and include a drawing.)

TECHNO-FILL

Environmental Studies Learning Concept

Technology can be applied to resource extraction, industrial production and waste management processes to reduce the generation of potential pollutants and control their release into the environment. Technology can also be used to clean up pollutants after they have entered the environment. Preventing the generation of hazardous materials and emissions costs less financially and environmentally than treating and controlling the release of pollutants or cleaning up pollutants after they have been released. Governmental policies and regulations about technology can be adopted to reduce or prevent pollution.

By using the best available technology, solid waste disposal facilities can reduce the potential for pollutants to enter the environment or reduce their harmful potential prior to release. Technology makes modern landfills and incineration facilities considerably safer than in the past; however, despite technological advances, concerns about pollution remain.

Vocabulary

biodegradation – the decaying of elements or cells of dead plants and animals into simpler substances

cell – the actual hole, dug in the ground, where waste is buried

clay soil – firm earth, made up of very small particles; used in the construction of sanitary landfills

construction – the act of building

corrosive – wearing away by chemical action

leachate – contaminated water that collects after rain runs through a landfill

methane gas – odorless, colorless, flammable gas

sanitary landfill – a facility where garbage is buried to protect our water and surrounding environment

technology – a method for handling a specific technical problem

toxic – poisonous

Overview - TECHNO-FILL



Activity 1: Landfill Lingo

Description

Students *read* a handout comparing old dumps with modern landfills and *interpret the meaning* of vocabulary terms critical to the text. In their own words, or by drawing pictures, students *compare* old methods of garbage disposal with modern waste disposal technology.

Ohio Proficiency Test Learning Outcomes

Grade 4, Reading #14 – Identify and interpret vocabulary (words, phrases or expressions) critical to understanding the text.

Grade 4, Reading #17 – Infer from the text.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Reading #12 – Infer from the text.

Grade 6, Science #4 – Identify the positive and/or negative impacts of technology on human activity.

Summary

This lesson has four activities. The first activity serves as an introduction for the subject matter in the other three activities; however, each activity can be conducted separately.

Activity 2: Does Your Soil Leak?

Description

Students *observe* a soil sample and *make calculations* using fractional analysis to *analyze* the soil sample. They *read* a handout about soil and landfill construction and *interpret the meaning* of various passages.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #7 – Illustrate or identify fractional parts of whole objects and like fractions greater than one, and add and subtract like fractions with illustrations and symbols.

Grade 4, Reading #14 – Identify and interpret vocabulary (words, phrases or expressions) critical to understanding the text.

Grade 4, Reading #17 – Infer from the text.

Grade 4, Science #2 – Select instruments to make observations and organize observations of an event, object or organism.

Grade 4, Science #8 – Evaluate observations and measurements made by other people.

Grade 6, Mathematics #6 – Compute with whole numbers, fractions and decimals.

Grade 6, Reading #12 – Infer from the text.

Grade 6, Science #3 – Make inferences from observations of phenomena and/or events.

Activity 3: Finer Liner

Description

Students *conduct an experiment* to determine the ability of soil and plastic material to retain water in a simulation of a landfill liner system. They are given a variety of materials (soil samples, plastic samples, etc.) and are required to make *inferences* to select the most appropriate materials for a landfill liner system. Afterward, they *analyze* the experiment to *evaluate* the procedure.

Ohio Proficiency Test Learning Outcomes

Grade 4, Science #6 – Evaluate a simple procedure to carry out an exploration.

Grade 4, Science #7 – Identify and/or discuss the selection of resources and tools used for exploring scientific phenomena.

Grade 6, Science #3 – Make inferences from observations of phenomena and/or events.

Activity 4: Life...Without Pollution Prevention

Description

Students *conduct an experiment* about the effects of pollution on plant life by adding various hazardous materials to water, which is then used to water plants. Students *identify* precautions that must be taken when using hazardous materials in an experiment and they *observe*, collect and *analyze* data. They *evaluate* the experiment and *make inferences* about how pollution affects the environment.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #24 – Make or use a table to record and sort information (in a problem-solving setting using simple and complex patterns in nature, art, poetry as setting) and make identifications, comparisons and predictions from tables, picture graphs, bar graphs and labeled picture maps.

Grade 4, Science #6 – Evaluate a simple procedure to carry out an exploration.

Grade 4, Science #9 – Demonstrate an understanding of safe use of materials and/or devices in a science activity.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Science #2 – Identify the potential hazards and/or precautions involved in scientific investigation.

Grade 6, Science #5 – Evaluate conclusions based on scientific data.

Grade 6, Science #17 – Analyze the impacts of human activity on the ecosystems of the Earth.

Background Information

Burying garbage is the most popular method of solid waste disposal in the industrialized world, except in a few countries in Europe where incineration is widely used.

During the past two decades, the number of landfills and open dumps has been decreasing in the United States. Ohio reflects that trend; in 1996, there were 75 landfills operating in the state, down from 300 in 1971. This reduction can be attributed to several factors, including stricter environmental standards that have forced the closing of many older landfills; greater difficulty in siting solid waste facilities; and the development of new landfills that are larger and must include costly pollution control **technology**.

As our industrial consumer society has developed throughout the 20th century, governments realized that the old technologies for burying and burning refuse created pollution problems, which threatened the quality of life, particularly in densely populated urban ecosystems. Open dumping attracted vermin, mosquitoes and pathogenic bacteria. Additionally, run-off from open dumps could contaminate soil and water, and methane gas migration could create fires and explosions.

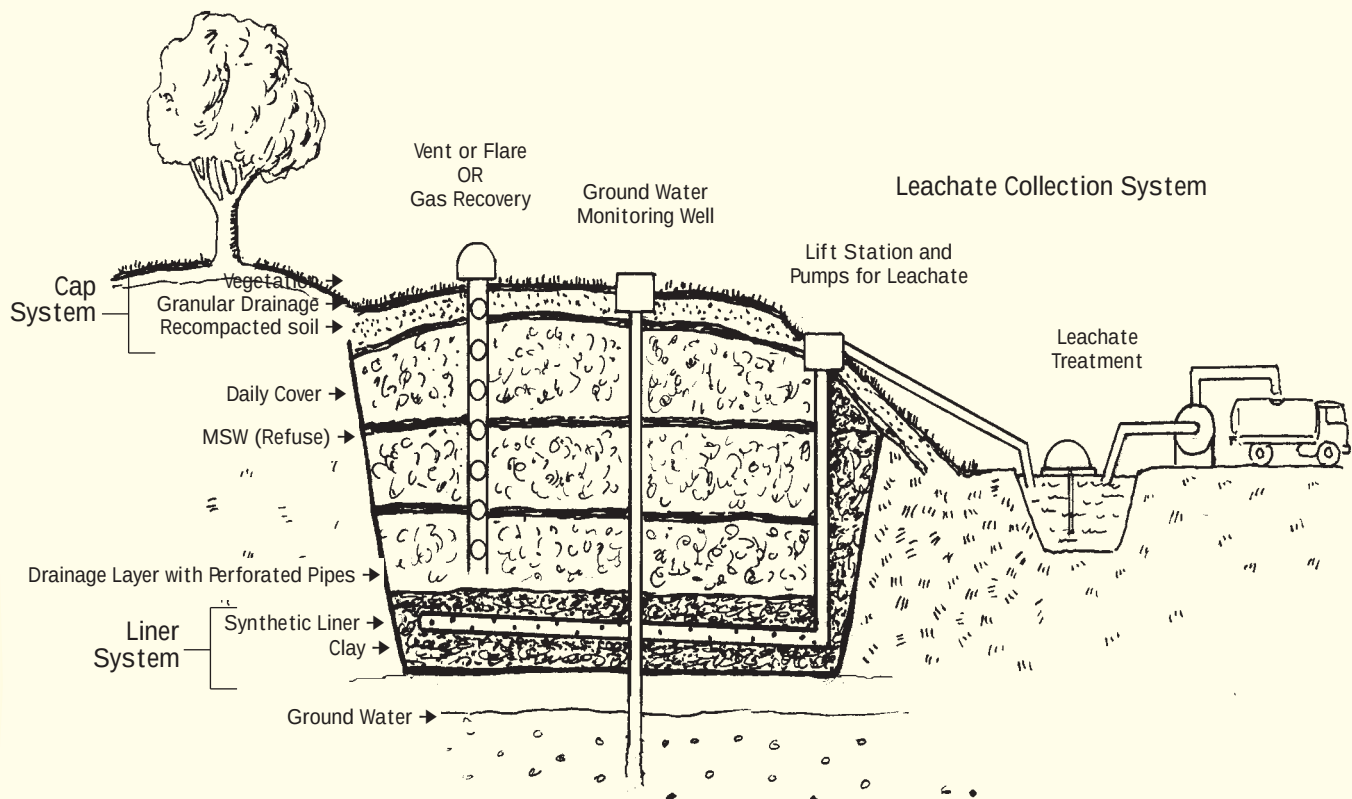
Landfills were initially developed to reduce the hazards of open dumps by compacting and covering refuse with soil. However, it was soon discovered that the potential for ground water pollution and **methane gas** migration still existed.

In order to solve the potential

problems of traditional disposal facilities, new standards were developed in the 1970s that motivated waste management businesses and civil engineers to develop new technologies for waste disposal. The modern **sanitary landfill** has become an important component in solid waste management.

However, much of the waste that is disposed in the U.S. is buried in landfills that still do not meet the standards for environmental protection provided by the modern sanitary landfill. On the other hand, older facilities are being closed as states and local governments are being pressured by the U.S. EPA and its supporting agencies to revise their programs.

Ohio has adopted strict standards for the **construction** and operation of new landfills including restricting the



Background Information, continued

building of landfills near water supply sources in geologically unfavorable locations and near recreation areas. Provisions must be made to protect and monitor ground water, inhibit soil pollution and erosion, and monitor methane gas migration. New requirements for the construction of landfills in Ohio include many “best available” technologies and operational methods characteristic of the modern sanitary landfill. Great care is taken in the construction and operation of a sanitary landfill to ensure that the potential environmental and health hazards associated with open dumps and traditional landfills are controlled.

A modern state-of-the-art landfill is composed of various systems, each addressing specific problems. Cover material, usually soil or a synthetic material, is spread over refuse daily to protect against vermin and blowing debris. Methane is vented to prevent explosion, and sometimes it is captured and sold as an energy source.

A drainage system is constructed to collect a potentially hazardous substance **leachate**, which forms inside the landfill. This system usually consists of perforated pipes placed above a liner in drainage layers filled with sand or gravel. To prevent leachate from percolating into aquifers, liner systems of clay and synthetic materials are used to trap the liquid. Pipes, connecting to a pump, carry the liquid to a holding pond for treatment and disposal. In order to monitor for signs of pollution, water wells and methane probes are dug around the

waste. When a landfill has reached capacity, it must be properly capped to keep moisture from seeping into the buried material.

Several factors contribute to the potential for leachate to become hazardous in a landfill. Residues and unused portions of household hazardous products, such as cleaners, solvents, motor oil and antifreeze, are sources of potentially harmful chemicals that mix into leachate. As organic waste breaks down, and as metals eventually oxidize and plastics degrade with all their additives, the potential exists for further contributions of **toxic** material. However, it is difficult to know the exact nature of and potential for pollution problems without knowing the specific materials and conditions that exist at any given site.

Although modern facilities may contain the best available technology as required by law, it is not certain how completely these new landfills protect the environment, especially in regards to air quality and ground water. For example, some laboratory tests reveal that clay liners can crack and plastic liners can tear under pressure.

Finally, modern landfills virtually entomb waste because it is very difficult for the waste to decompose, whereas that used to be the natural process at open dumps. By relying on modern landfills for disposing so much of our waste material, we are literally storing our waste, rather than allowing it to degrade or be recovered for reuse.

Bibliography and Additional Resources

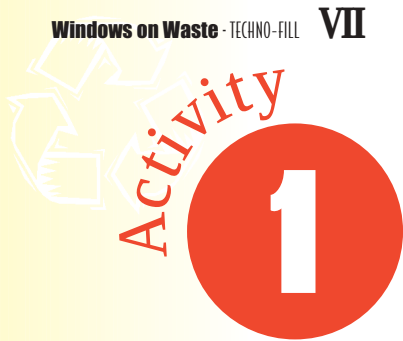
Student Resources

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Educator Information

The Museum of Solid Waste and Energy, “Station 8, Landfilling” The National Energy Education Development (NEED) Project. (703) 860-5029.

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TECHNO-FILL

Landfill Lingo

Objectives

Students will be able to: (a) compare the old method of disposing waste to the new technology used in a modern waste disposal facility; (b) explain the different components of a sanitary landfill; and (c) describe how human activity can affect the environment when waste is improperly disposed.

Procedure

- 1 Have students draw a picture of the place where their garbage goes and label the parts. Collect and set aside for later use.
 - 2 Have students read the handout, *Techno-Pollution Prevention*, and complete the handout, *Mix and Match Waste Game*.
- ANSWERS** to *Mix and Match Waste Game*: 1. c, 2. a, 3. b, 4. e, 5. h, 6. g, 7. i, 8. d, 9. f, 10. j
- 3 After students have completed the handout, review the words and the correct answers.
 - 4 Have students complete the *Waste Word Search* handout. Students should be familiar with the vocabulary words by now and able to identify the words in a reasonable amount of time.
 - 5 Ask students how their lifestyles affect the environment based on habits of consumption and waste generated.

See p. VII-8 for **ANSWERS** to *Waste Word Search*.

Assessment

- 1 The handout, *Mix and Match Waste Game*, can be used as a pre- and post-test. Have students complete the handout before and after they have read the background information to assess how much they learned.
- 2 Have students draw another picture of the place where their garbage goes and label the parts of it. Compare with their original drawings.

Inquiry

- How can waste be disposed of safely?

Content Domain

Reading – Reading comprehension

Science – General science, physical science, earth science

Learning Outcomes

Reading, Grade 4, #14, #17 and Grade 6, #12

Science, Grade 4, #14 and Grade 6, #4

Duration

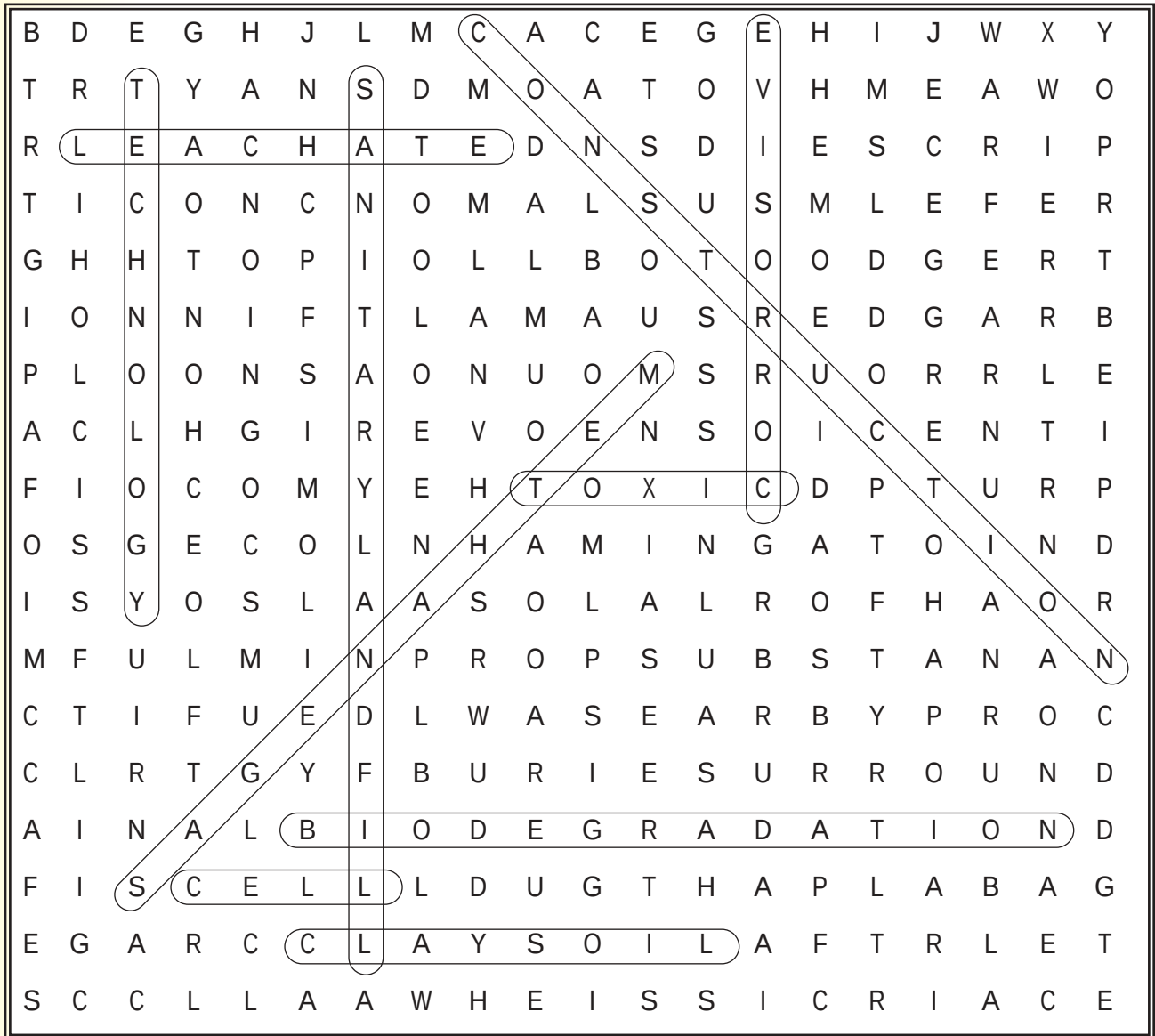
45 minutes

Materials

Writing and drawing materials

Handouts

- [Techno-Pollution Prevention](#)
- [Mix and Match Waste Game](#)
- [Waste Word Search](#)

Key to Waste Word Search, page VII-11

Student Handout

TECHNO-POLLUTION PREVENTION

From dumps to landfills

Not long ago the waste created by the average household was put into a pit or field called a dump. Most cities or villages had their own dumps. Trash was trucked daily to the dump, and occasionally, some soil was thrown on top of the trash to cover it, so rats and other vermin would not be attracted to the site. However, other problems still existed.

Toxic materials in trash can seep into the soil and find their way into groundwater, contaminating wells and other sources of drinking water. This sometimes happened when trash was placed in an open dump. Because of contamination, the open dumps of the past have been replaced with **sanitary landfills**, which use modern technology to protect our water supply and prevent other problems.

Because of the hazards of rats, flies, mosquitoes and air and water pollution concerns, laws were enacted requiring the use of “*best available*” **technology** in the construction of new landfills.

Trash is still buried in a hole dug in the earth, also called a **cell**, but the method used to construct and prepare the cell before waste is disposed, is very different from the old method.

How do you build a sanitary landfill?

It takes several years of planning to design and site a sanitary landfill. The landfill’s plan is presented to governmental agencies and local residents, who must be convinced of the need for and the safety of the proposed landfill. Once approved by local and state agencies, **construction** begins.

Soil and liner

First, the cell is dug and lined with at least 5 feet of **clay soil** along the sides and bottom of the cell. The clay is then compacted to make it strong and firm.

Then a plastic liner, which must be very strong, is placed on top of the clay soil. Because heavy equipment will drive over the trash to compact it in the cell, the liner must be able to withstand the weight of the trash and the pressure of the trash being compacted.

The liner must also be waterproof and chemical-proof. It must keep all of the **toxic** and **corrosive** chemicals we throw away (such as bleach, insect spray, household cleaners, oil, etc.) from destroying the liner. The liner must be able to retain the rainwater that trickles through the trash, because when rainwater mixes with all of the chemicals in the garbage it creates a potentially toxic liquid called **leachate**.

Leachate collection system

A network of pipes collects the leachate at the bottom of the cell and pumps it to the surface of the cell where it is then transferred into a pond or storage tank. The leachate is either treated at the landfill or transported to a sewage treatment plant. At the treatment plant, the toxic or poisonous substances are removed from the polluted water so the water is safe to use again.

Methane gas control

Landfills contain organic matter like leaves and food. The process of decaying organic matter is called biodegradation. **Biodegradation** (when microorganisms chemically break down dead plant and animal matter) produces a gas called methane. Methane gas is colorless and odorless, but it has the potential to be dangerous to people and the environment. **Methane gas** can catch fire and also explode under certain conditions. New rules require that pipes run down into a cell, which allows methane gas to escape. Sometimes the gas is captured and used as a fuel to produce energy. Sometimes it is burned off to keep it from escaping into the environment.

Now you can understand why we call a modern sanitary landfill a pollution prevention technology.

Student Handout

MIX AND MATCH WASTE GAME

Directions: Match the words in the left column to the descriptions in the right column.

1 _____ sanitary landfill	A. dirty water that collects after rain runs through a landfill
2 _____ leachate	B. the actual hole, dug in the ground, where waste is buried
3 _____ cell	C. a facility where garbage is buried to protect our water and surrounding environment
4 _____ methane gas	D. harmful
5 _____ corrosive	E. odorless, colorless, flammable gas
6 _____ clay soil	F. a method of solving a problem by using materials and machines
7 _____ biodegradation	G. firm earth, made up of very small particles used in the construction of sanitary landfills
8 _____ toxic	H. wearing away by chemical action
9 _____ technology	I. the process of natural material breaking down and decaying
10 _____ construction	J. the act of building something

Student Handout

WASTE WORD SEARCH

Directions: The vocabulary words in this unit are hidden below. Circle as many of the waste words as you can find. WORDS CAN BE DIAGONAL, BACKWARDS, ACROSS, UP OR DOWN. If an answer is two words (clay soil) the space between words has been left out.



biodegradation

clay soil

corrosive

methane gas

technology

cell

construction

leachate

sanitary landfill

toxic

TECHNO-FILL

Activity
2**Inquiries**

- What is soil?
- How can different soils be defined?
- Which type of soil is the most suitable to use in the construction of a modern landfill?

Content Domain

Language Arts – Reading comprehension

Math – Arithmetic

Science – Earth science

Learning Outcomes

Math, Grade 4, #7 and Grade 6, #6

Reading, Grade 4, #14, #17 and Grade 6, #12

Science, Grade 4, #2, #8 and Grade 6, #3

Duration

Two to three days

Materials

To perform your own at-school soil fractional analysis, you'll need the following supplies: **clear jar with a tight-fitting lid; 1 cup of finely pulverized soil** (use a mallet or rolling pin to pulverize it); **1 teaspoon of non-sudsing, low phosphate dishwasher detergent; watch or clock; crayon or grease pencil**

Handouts

- *It's Not Just Dirt*
- *Does Your Soil Leak?*

Does Your Soil Leak?

Objectives

Students will be able to: (a) identify different types of soil particles; (b) describe why clay soil is used in the construction of a modern landfill; (c) classify types of soil by testing soil samples; and (d) determine if soil is suitable for use in landfill construction by measuring and calculating a fractional analysis.

Preparation

Collect enough soil from your yard or school ground to fill as many jars (half-full) as you plan on using. You might also obtain soil samples from your local Soil and Water Conservation District office or Extension office. Use a sample that includes sand, silt and clay particles. You can usually obtain clay from around the foundation of a building where the soil has been removed for a basement. If you think the soil in your area doesn't contain enough sand, add builders or sandbox sand to the sample.

You can do this experiment as a class with one jar or have each student bring in a jar. The jar should be clear, and the same size at the top as the bottom and have a tight-fitting lid.

If you want students to see the different particle sizes after you separate the soil particle types, you can use a microscope to see the silt and clay particles.

Procedure

1 Read the handout, *It's Not Just Dirt*, to the class or have students read it. You may want to cover the bottom of it, and have students make inferences before reading it. Remind students they will be determining if the soil at a certain site would be suitable soil for use in the construction of a modern landfill.

2 Fill the jar two-thirds full of water, add the soil and detergent, and fasten the lid securely. Shake the jar vigorously for 10 to 15 minutes. The sand particles are the largest and heaviest and will settle to the bottom of the jar within minutes. Mark the jar with a crayon at the end of one minute to indicate the level of sand. After two hours most of the silt will have settled; so make a second mark on the side of the jar to indicate the level of silt. Clay particles are tiny and will require a few days to settle; when the water is clear the particles have all settled. Finally, on the jar, mark the level of clay.

3 To determine the percentage of each type of particle, use the following formula:

A equals the thickness of the sand

B equals the thickness of the silt

C equals the thickness of the clay

D equals the thickness of all three deposits

- To calculate the percentage of sand, multiply **A** by 100 and divide by **D**.
- To calculate the percentage of silt, multiply **B** by 100 and divide by **D**.
- To calculate the percentage of clay, multiply **C** by 100 and divide by **D**.

Assessment

Completing the fractional analysis problem correctly. Have students complete the handout, *Does Your Soil Leak?*

ANSWERS to *Does Your Soil Leak?*

1. b, 2. d, 3. c, 4. a

$$\mathbf{A + B + C = D}$$

Example:

Sand = A = $\frac{1}{2}$ "

Silt = B = $\frac{1}{4}$ "

Clay = C = $1\frac{1}{4}$ "

Total = D = 2"

$$\mathbf{A} = \frac{1}{2} \times \frac{100}{1} = \frac{100}{2} = 50 \div 2 = 25\%$$

$$\mathbf{B} = \frac{1}{4} \times \frac{100}{1} = \frac{100}{4} = 25 \div 2 = 12.5\%$$

$$\mathbf{C} = 1\frac{1}{4} \times \frac{100}{1} = \frac{5}{4} \times \frac{100}{1} = \frac{500}{4} = 125 \div 2 = 62.5\%$$

If your soil sample contains 40-60 percent clay particles, it is considered clay soil. The higher the percentage of clay particles, the more suitable it is for lining a landfill.

Student Handout

IT'S NOT JUST DIRT!

Soil is composed of organic and inorganic matter. Organic matter in soil comes from plants and animals as they die and decay back into the ground.

Inorganic matter comes from minerals that resemble tiny pieces of rock-like material.

The mineral portion of almost every soil contains sand, silt and clay. The percentage of each of these types determines the soil's texture. Texture refers to the size of particles that make up soil. Structure refers to the way the soil particles fit together. Soil particle texture and structure are very important in determining where a landfill is situated.

Sand particles are the largest and most irregular in shape and measure from $\frac{1}{50}$ to $\frac{1}{500}$ of an inch. Sandy soil doesn't have much clay or organic matter. Even when wet, the soil particles don't stick together and have large spaces between them, which causes it to drain very quickly.

Silt particles range from $\frac{1}{500}$ to $\frac{1}{12,500}$ of an inch. Silty soil tends to have a large percentage of small particles although they are generally larger than the particles in clay soil. The small particles fit together densely and drain slowly, but more quickly than soil with a high percentage of clay particles.

Clay particles are the smallest and are less than $\frac{1}{12,500}$ of an inch. Soil dominated by 40 to 60 percent clay, becomes sticky and practically unworkable when wet, and hard and cloddy when dry. The spaces between the particles are so small that clay soil becomes completely waterlogged when wet. Clay soil drains slowly. Because of the small size of the particles, the soil compacts very well and contains very little space for water to drain through. Clay soil is also generally low in organic matter.

Do you know which type of soil would be the best to use at the bottom of a landfill?

When constructing a sanitary landfill, the first step after the cell is dug in the ground is to line the cell bottom and sides with at least 5 feet of tightly compacted clay soil. Clay soil is used because of its texture and structure. The particles are very small and pack together tightly. This helps to keep water and toxins from draining through and polluting ground water.

Constructing a modern landfill where the soil deposits are high in clay content is an advantage, because there is plenty of soil to use for the soil liner, which acts as a natural buffer between the landfill and the surrounding environment.

Student Handout

DOES YOUR SOIL LEAK?

Directions: Put the letter of the correct response in the blank space beside each question.

- _____ 1. Soil consists of three major types of soil particles. These soil particles are different sizes. Which type of soil particle is the smallest?
- a. silt
 - b. clay
 - c. sand
 - d. organic matter
- _____ 2. When constructing a sanitary landfill, a hole or cell is dug and then lined with the best type of soil. How many feet of soil are used to line the landfill cell?
- a. 2 feet
 - b. 12 feet
 - c. 4 feet
 - d. 5 feet
- _____ 3. Look at the jar of soil you used to do your experiment. The lines on the jar mark the separation of the three different types of soil particles. Which type of soil particle is the heaviest?
- a. clay
 - b. organic matter
 - c. sand
 - d. silt
- _____ 4. If the soil with the smallest particle size is the best soil to use as the soil liner in the construction of a sanitary landfill, which type of soil particle is used?
- a. clay
 - b. sand
 - c. silt
 - d. organic matter

TECHNO-FILL

Activity
3

Finer Liner

Inquiry

- How does the liner system used in the construction of a sanitary landfill help prevent environmental pollution?

Content Domain

Science – Earth science

Learning Outcomes

Science, Grade 4, #6, #7 and Grade 6, #3

Duration

50 – 60 minutes

Materials

Samples of: **sand, gravel, clay soil (or modeling clay), plastic trash bag, plastic cone shaped cups** any color (7 oz. cups work well); **clear plastic cups** (any clear cup that will hold the smaller cup will work); a **pitcher of water** with **food coloring** added; **scoops** or **spoons** for students to use to scoop out materials used to build liners; and **any other materials** you want to add, such as **potting soil**, different sizes of **gravel** or **trash bags of varying thickness**.

Handout

- [Landfill - Pollution Solution Self-Evaluation](#)

Objectives

Students will be able to: (a) conduct an experiment to determine the effectiveness of different liner materials in slowing or stopping leachate from draining through the liner; and (b) evaluate and modify the experimental procedure and materials.

Preparation

The objective is to build a liner in the smaller cup. The liner cup needs to have a small hole punched in the bottom. The liner cup is placed inside the clear cup, with enough space in the bottom after the liner cup is inserted, to see if any colored water leaks through the hole.

Procedure

- 1 Discuss with students the potential problems associated with burying garbage in the ground and why liner systems are used in landfills.
- 2 Give each student or pair of students a plastic cone cup with a hole punched in the bottom and a clear plastic cup. Have them write their names on the clear cup.
- 3 On a table, lay out a variety of materials: sand, soil, modeling clay, gravel of different sizes, potting soil and an assortment of plastic bags of varying thicknesses. Ask students to predict which combination of materials will make the most efficient liner for a landfill. Students are allowed to select any combination of available materials to line his/her cone cup.
- 4 When students have finished constructing their landfill liners, fill a pitcher with water and add food coloring. Fill each cup with water and have students record the results.
- 5 Ask students to explain why they think their combination of materials held the water or leaked.
- 6 Add water each day and record the results.
- 7 At the end of the week, discuss which type of liner worked the best.
- 8 Discuss with students the objectives of the experiment and its relationship to real life. Have them evaluate the procedure they used to conduct the tests. Would they design the experiment differently next time?
- 8 Based on responses to the previous step, have students redesign and conduct an additional experiment.

Assessment

Have each student evaluate his/her participation using the handout, *Landfill – Pollution Solution Self-Evaluation*.

Student Handout

LANDFILL – POLLUTION SOLUTION SELF-EVALUATION

Directions: Read each statement and answer honestly. Using the code, place a 0, 1 or 2 in the space provided by each statement. Write a paragraph about what you learned from completing the activity.

Code: 2 = often
1 = sometimes
0 = never

_____ I followed instructions (including safety rules) carefully.

_____ I actively participated in the activity.

_____ I participated in class discussion.

_____ I completed all tasks to the best of my ability.

_____ I helped clean up after the activity.

As a result of completing this activity, I learned the following:

If you need additional space, use the back of the sheet.

TECHNO-FILL

Activity
4

Life...Without Pollution Prevention

Inquiry

- How can pollutants in our water affect living organisms in the environment?

Content Domain

Math

Science – General science, biology

Learning Outcomes

Math, Grade 4, #24

Science, Grade 4, #6, #9, #14 and Grade 6, #2, #5, #17

Duration

Two to four weeks

Materials

Six plant containers (plastic cups or clean margarine containers), **six plants of the same size and type**; **six jars with lids**; **five different common household chemicals** (examples: bleach, dish soap, cooking oil, window cleaner, drain cleaner); **water**; **potting soil**

Handouts

- [Toxic Soup](#)
- [Toxic Soup Evaluation](#)
- [Experiment Group Evaluation](#)

Objectives

Students will be able to: (a) identify potential hazards in scientific investigation and demonstrate safe use of materials; (b) evaluate a scientific procedure; and (c) collect and evaluate scientific data about potential pollution problems associated with the improper disposal of waste materials.

Procedure

1 Divide students into six groups. Give each group a label - A through F. Each group will need a cup or container, potting soil, jar with lid, plant, water and one of the five household chemicals. Give one group water only.

2 Have students label each cup. For example: Group A-control, Group B-bleach, Group C-dish soap, Group D-cooking oil, Group E- window cleaner and Group F-drain cleaner. Discuss with students proper safety precautions when handling potentially hazardous materials in an experiment. Refer to Appendix C in *Ohio's Competency Based Science Program*.

3 Have groups fill their jars in the following order: Fill Jar A with plain water. Fill Jar B with 5 parts water to 1 part bleach. Fill Jar C with 5 parts water to 1 part dish soap. Fill Jar D with 5 parts water to 1 part cooking oil. Fill

Jar E with 5 parts water and 1 part window cleaner. Fill Jar F with 5 parts water to 1 part drain cleaner.

4 Have students fill their cups with potting soil, and place their plants in the container.

5 Have students water the plants with the water jar that matches their group's letter. Water Group A's plant with water from Jar A, and so on. Water all of the plants once or twice each week, always using the same measurement of water for each plant. Keep the plants in a sunny place, such as a windowsill, and keep the room temperature consistent for each plant.

NOTE: Use extreme caution when handling dangerous materials. Keep all watering jars away from students, distribute them when watering is needed and monitor watering closely. Consider watering the plants for younger students.

6 Set up a chart listing A through F for each plant. Keep track of the dates the plants were watered and how much water was used. Also, measure the growth of the plant (if any). Chart plant growth and general conditions of the plant (good, fair, poor, dead). Students in each group should take turns caring for plants and charting. Final data can be represented by having students construct a picture, bar or line graph.

7 Have students continue to water and chart or graph plant data for two to four weeks, depending on the length of time you have to complete the activity.

8 Discuss the results and following questions with the class.

- How many plants are still alive?
- What is the condition of each plant?
- What might happen to the ground water if appropriate pollution prevention technology isn't used?
- Would plant life be at risk?
- Would people and animals be at risk?
- What role does the liner at the bottom of the landfill cell play in preventing pollution?

9 Discuss the nature of the experiment and how the results might vary if different procedures were used. Groups could change variables such as different types of plants, different concentrations of water and chemicals, different environmental conditions, such as low light, high light, cool temperatures, hot temperatures, etc.

10 Give students the handout, *Toxic Soup*, to read. Then have them complete the handout, *Toxic Soup Evaluation*.

Rubric: Total possible points - 12

- 0 = inaccurate explanation
- 1= provides partially accurate explanation
- 2 = provides accurate explanation but not well written
- 3= provides well written and accurate explanation

Assessment

Assessment is accomplished by completing and charting the experiment's results and completing the handout, *Experiment Group Evaluation*.

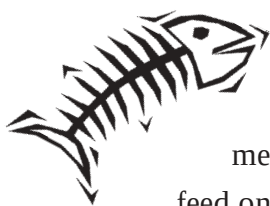
Student Handout

TOXIC SOUP

When rain or surface water comes in contact with decomposing waste, a potentially harmful substance called **leachate** is created. Leachate, if it drains through the bottom of a landfill or dump, may reach ground water. If leachate reaches an impermeable layer of rock or soil, it may flow on top of the layer and drain out of the ground into a waterway. Hazardous substances, when disposed at an improperly maintained landfill or dump, can run along the top of the ground and reach waterways. In order to protect our underground water sources, it is important that our landfills are designed and constructed properly.



Ohio law requires the construction of “best available” technology landfills. In a best available technology landfill, a **clay soil liner**, **plastic liner** and a leachate collection system are required. The liners are needed to trap leachate and keep it from reaching ground water sources. Once leachate develops in a landfill cell, it must be drained from the cell or over time it could eventually fill up and overflow. That is why a **leachate collection system** is necessary. It captures leachate through a network of pipes laid on the bottom of the cell. A pump moves leachate up off the cell floor. The leachate is either treated on-site or transported to a sewage treatment plant, where harmful chemicals and organisms are removed and the water is made safe to use again.



However, for various reasons, **toxic** substances are not always removed or properly treated, and they can be discharged into connecting waterways (a creek, stream, river, or lake). In a sewage treatment plant, sometimes hazardous wastes kill the living organisms that feed on the harmful bacteria in organic waste. Therefore, it is very important that pollution be controlled as much as possible at the landfill site, so it does not spread to the rest of the environment.

Student Handout

TOXIC SOUP EVALUATION

Directions: Read the handout, *Toxic Soup*, and answer the questions below.

1. How is leachate created?

2. Currently, Ohio law requires that the “best available” technology be used when building new landfills. In the handout, *Toxic Soup*, three components of “best available” technology are mentioned; one is a clay soil liner. What are the other two components?

- (1) _____
- (2) _____

3. How is leachate removed from a landfill and what is done with it?

4. How can leachate affect the environment if it isn't properly contained?

Student Handout

EXPERIMENT GROUP EVALUATION

Code: 2 = most of the time
 1 = sometimes
 0 = never

Directions: Read each statement and using the code, place a 0, 1 or 2 in the space provided by each statement. Write a paragraph about what your group learned from completing the activity. Discuss with your group, ways you could improve your work as a group and write in the space provided.

Activity _____ Date _____

Group Members:

- _____ We followed directions carefully.
- _____ We used materials safely.
- _____ We worked well together and got along as a group.
- _____ We all had a role in the group.
- _____ We took turns collecting and organizing data on the chart.
- _____ We helped clean up after the activity.

Our group acquired the following ideas or skills as a result of this activity:

We could improve our work as a group by:

If you need additional space, use the back of the sheet.

RESOURCE EXPEDITIONS

Environmental Studies Learning Concept

The origin of all our material goods is natural resources. Natural resources (minerals, petroleum, timber, water, wildlife, plants, etc.) serve as sources of energy and raw materials for the manufacturing processes used to make consumer products. They are acquired from all over the Earth by extracting them from the land or using the land to provide nutrients for their growth. Natural resources are either renewable or non-renewable in nature; but even renewable resources can be depleted.

History indicates that settlements near resource extraction industries can prosper as well as become degraded. Proper resource management includes resource extraction practices that conserve resource availability for future generations and initiatives for pollution control and reclamation.

The acquisition of resources depends on many factors including technology, scientific knowledge, economic factors, population growth and carrying capacity. The demand for consumer products, and thus natural resources, is also dependent upon the values, wants and needs of customers. Governments can create policies that either reduce or increase the use of natural resources through market intervention and regulations.

Recycling uses, in varying percentages, secondary (recycled) materials in place of primary materials (natural resources) in manufacturing processes. Recycling conserves resources by reducing the need to extract them from the Earth. Recycling also lessens land degradation and pollution associated with resource extraction industries. Reduction in consumption and use of materials and reuse of products and materials are practices that also conserve natural resources.

Vocabulary

carrying capacity – the maximum population of a given organism that a system can sustain without being degraded

consumer products (goods) – tangible commodities produced and purchased to satisfy human needs or desires

ecosystem – a system made up of a community of living things and the physical and chemical environment in which they interact

fossil fuel – a hydrocarbon deposit, such as petroleum, coal or natural gas, derived from living matter of a previous geologic time and used for energy

homogenous – of the same or similar in nature or kind

mineral – a naturally occurring, homogenous, inorganic solid substance having a definite chemical composition and characteristically crystalline structure, color and hardness

mining – the process or business of extracting ore or minerals from the ground

natural resources – raw materials, such as minerals, petroleum, timber or water, which occur in nature and are required to make consumer products

non-renewable resource – organic material that cannot be renewed or regenerated except over very long periods of time

pollution – the contamination of soil, water or air by the discharge or improper disposal of harmful substances

reclamation – a restoration, as to productivity or usefulness

recycling – the act of collecting, separating and processing materials from the solid waste stream for use as raw materials in manufacturing processes

renewable resource – organic material, which can be renewed or regenerated by natural ecological cycles or sound management practices

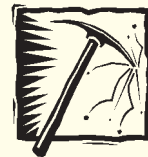
reuse – taking a component of solid waste and modifying it for new functional purposes; using a product more than once in its same form

solid waste management – the systematic administration of activities which provide for the collection, source separation, storage, transportation, transfer, processing, treatment and disposal of solid waste

solid waste – garbage, refuse, sludge and other discarded materials and residues including those from industrial, commercial and agricultural operations, and community activities

sustained yield – managing resources (forests, agriculture, etc.) so that they produce continuously, unimpaired by periodic harvests

Overview – RESOURCE EXPEDITIONS



1

Activity 1: Show 'Em Sherlock

Description

Students *cooperate in groups* and *analyze* information in a mystery game to discover which of five recyclable materials is their group's identity. Each player is given a clue card for one of the five materials and moves from station to station while student "super sleuths" at each station *make inferences* about the clue to decide if it represents the correct material for his/her station. At each station, students share their clues and *interpret* information to discover the nature (material) of their homogenous group and solve the mystery. Students *organize information* about resources and materials by using a dichotomous key. They *make inferences* from the information gathered about the effect of recycling upon the environment.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #11 – Name the resources needed to produce various goods and services.

Grade 4, Science #1 – Create and/or use categories to organize a set of objects, organisms or phenomena.

Grade 4, Science #4 – Use a simple key to distinguish between objects.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Science #1 – Use a simple key to classify objects, organisms and/or phenomena.

Grade 6, Science #17 – Analyze the impacts of human activity on the ecosystems of the Earth.

Summary

This lesson includes two activities. They may be conducted separately; however, the first activity provides a good background for the second activity.

Activity 2: Mining and Recycling

Description

Students read a list of consumer items and *rank order* the value of the items. They *conduct research* to *identify* the natural resources used to make their favorite item and from a list of resources used to make an automobile, they *identify* which materials are common recyclables. Students *manipulate materials* to simulate a mining operation using chocolate chip cookies. They *analyze* information and *compute figures* to determine the financial and environmental costs of obtaining natural resources from the Earth.

2



Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #3 – Select appropriate notation and methods for symbolizing a problem situation, translate real life situations into conventional symbols of mathematics, and represent operations using models, conventional symbols and words.

Grade 4, Mathematics #8 – Add, subtract, multiply and divide whole numbers and explain, illustrate or select thinking strategies for making computations.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Mathematics #3 – Apply appropriate notations and methods for symbolizing the problem statement and solution process.

Grade 6, Science #4 – Identify the positive and/or negative impacts of technology on human activity.

Grade 6, Science #17 – Analyze the impacts of human activity on the ecosystems of the Earth.

Background Information

All our material goods originate from **natural resources**. Natural resources are raw materials, such as **minerals**, petroleum, timber, water and other resources (wildlife, plants) and are required to make the products used in our consumer society. Natural resources are either **renewable** or **non-renewable** in nature and can serve as either sources of energy or as raw materials for manufacturing **consumer products**. Even renewable resources can be depleted.

Raw materials can be in the form of primary materials or secondary materials. Primary materials are those resources, renewable or non-renewable, taken directly from nature. Secondary materials are resources that are collected from the waste stream to be reused.

Natural resources, used for energy and raw materials to make consumer products, are extracted from the earth through the **mining** of minerals, the drilling of oil and gas wells, and the

harvesting of organic resources, such as trees. Resource extraction industries generate large quantities of **solid waste**, some hazardous in nature, and consume large amounts of energy. Without proper management, our resources can be exploited, resulting in environmental degradation and possibly a decline in lifestyle.

Proper resource management includes recycling and sustainable resource acquisition. Using secondary materials instead of primary materials defers the need to extract resources from nature, thereby conserving these resources. **Sustained yield** is a resource acquisition practice that conserves resource availability for future generations. Sustained yield means acquiring natural resources (timber, water, minerals, etc.) in a way that ensures continuous production.

Resource conservation is also a function of **carrying capacity**. The carrying capacity of an **ecosystem** is the number of living things a system can support without degradation. Problems arise when a population exceeds the limit that the resource

base can support without stress—its carrying capacity. Theoretically, there is a maximum population matched to each resource base, although it is very difficult to determine. In human history, there are examples of societies that experienced developmental decline coinciding with an exploitation of the resource bases used to meet the needs and wants of growing populations.

In addition to population and demand for resources, carrying capacity is influenced by how resources are managed and whether technology increases resource use or makes more efficient use of natural resources.

Sustainable development implies living within the bounds of carrying capacity, thereby balancing the needs and wants of humans with the needs of the Earth. Appropriate technology, such as recycling, helps because it meets human needs with minimal long-term damage to the environment. Recycling is a way of managing our solid waste and natural resources to reduce environmental degradation and consumption of finite resources.

Background Information, continued**Bibliography and Additional Resources****Student Resources**

The Giving Tree, by Shel Silverstein, New York: Harper Collins, 1974.

Window, by Jeannie Baker, New York: Greenwillow Books, 1991.

The Lorax, by Dr. Seuss, New York: Random House, 1971.

Old Turtle, by Douglas Wood, Deluth, Minn.: Pfeifer-Hamilton, 1992.

Brother Eagle, Sister Sky, (words from

Chief Seattle, with paintings by Susan Jeffers), New York: Dial Books, 1991.

The Great Kapok Tree, by Lynne Cherry, San Diego: Harcourt, Brace, Jovanovich, 1991.

Common Ground, by Molly Bang, New York: Blue Sky Press, 1997.

Mother Earth, by Nancy Luenn, New York: Maxwell MacMillian, 1992.

The Environment—Distinguishing Between Facts and Opinions, Greenhaven Press, 1990.

'Fish Banks, Ltd.' created by Dennis

Meadows. IPSSR, Hood House, University of New Hampshire, Durham, NH 03824.

Metals in History and *The Horn of Plenty Still Flows*, published by the U.S. Bureau of Mines, Office of Public Information, 1991 and 1992.

Educator Information

Population Program, NWF, 1400 16th St. NW, Washington, DC 20036.

The American Coal Foundation, 1130 17th St., NW, Washington, DC 20036.

Activity 1

Show 'Em Sherlock

Objectives

Students will be able to: (a) identify products made from natural resources and from recycled materials; (b) distinguish various types of resources and products in a dichotomous key; and (c) explain the value of recycling for conserving natural resources.

Preparation

Prepare large definition cards, or plan to use space on the blackboard, to define the following terms: natural resources, renewable natural resources, non-renewable natural resources, plants, animals, fossil fuels, minerals, sandstone, oil, bauxite, iron ore, trees.

Anticipate selecting five students who will each be assigned one of the following: paper, plastic, steel, aluminum or

glass. It is important to select students who are capable of taking on the role of super sleuth. (*This must be top secret* - they are the super sleuths and do not know the product identity of the other super sleuths.) Scan Part A of the activity to understand their roles. The role of Super Sleuth can be made easier by writing the answers (to the clues from the cards that match their material - glass or plastic or paper, etc.) on the back of their detective lens.

RESOURCE EXPEDITIONS

Inquiries

- What are natural resources and how are they used to make consumer products?
- What are recycled materials and when can they be used instead of natural resources?

Content Domain

Science – General science, earth science

Social Studies – Economics

Learning Outcomes

Citizenship, Grade 4, #11

Science, Grade 4, #1, #4, #14 and Grade 6, #1, #17

Duration

Part A: 50 minutes

Part B: 50 minutes

continued next page

RESOURCE EXPEDITIONS

Materials

Thirty printed clue cards (from the handout pages, *Clue Cards*), **plus one blank card** to adapt to individual needs; **five printed “magnifying lenses,”** cut out from multiple copies of the handout, *Super Sleuth Detective Lens*, **with one of the following words written on the back of each lens: glass, aluminum, steel, paper/cardboard or plastic; five examples of products made from the resources, sandstone (glass jar), bauxite (aluminum can), iron ore (steel can), trees (paper/cardboard), oil (plastic milk jug)**

Handouts

- *Clue Cards (1-8)*
- *Super Sleuth Detective Lens*
- *Goods and Resources*
- *The Nature of Natural Resources*

Procedure

PART A

1 Divide the class into five groups or stations and select five super sleuths, one for each group. Give each super sleuth a detective lens. It is each super sleuth's responsibility to lead their group's discussion and determine whether the clues match his/her category.

2 Distribute the clue cards (face down) to the class and meet privately with the super sleuths to give each of them their secret identity (written on the back of their detective lens with or without the answers) and instructions as follows:

As a super sleuth, you must have each student read his/her clue card aloud to the group. You will select those students who hold cards that match your identity without telling them why you selected them to stay at your station. When a signal is given, the rest of the group at your station moves to the next station. During the game, your station may be crowded, or it may have only one student.

3 Set the scene for the class by reading these instructions to them.

Who's in the mood to solve a mystery today? If I say Sherlock, who am I talking about? That's right – Sherlock Holmes. Created by an English writer (Sir Arthur Conan Doyle) in 1887, Sherlock Holmes was a fictional detective who prowled the streets of London. His trusty assistant, Dr. Watson, helped gather clues, and together they solved countless mysteries. To solve today's mystery, you must become detectives like Holmes and Watson, listening and observing.

Five of you have been chosen to be super sleuths and have been given a secret identity on the back of a magnifying glass. The rest of you have been given clue cards which will be read and re-read at five stations. When the super sleuth asks you to read your clue aloud, all of you at the station need to listen carefully because there

*are clues hidden within the clue cards. The super sleuth is trying to find those who belong to him/her. When you read your clue at each station, the super sleuth will either ask you to stay or leave. Only those students the super sleuth thinks **do not belong** will move on to another station. This process will be repeated five times. By the end of the game, you will be in a group where each of you has something in common. This is called a homogenous group. As you play the game, keep an “eye” on the classroom for more clues.*

ANSWERS to *Clue Cards*:

Aluminum – 1, 9, 15, 17, 21, 29

Glass – 2, 8, 13, 20, 24

Paper/Cardboard – 4, 7, 11, 16, 23, 28, 31

Plastic – 3, 6, 14, 19, 22, 26, 30

Steel – 5, 10, 12, 18, 25, 27

4 Before beginning the game, display the natural resources definition or write “natural resources” on the board. After the third rotation, place the five products (plastic milk jug, glass jar, aluminum can, steel can, paper/cardboard, or whatever products you chose) in sight. After the fourth rotation, prominently display the five natural resource (oil, sandstone, bauxite, iron ore, trees) definitions or write the terms on the board.

NOTE: It may take at least one rotation for the students to start “getting it.” Make sure everyone is participating. Remind students they are trying to find matches and make connections.

5 After the fifth and final rotation, ask the super sleuths to reveal their identities to the students at their stations and then to the class. Identify the “strays” (those who are at the wrong station) and help everyone find the correct station.

6 Explain homogenous to the class. Now, within the homogenous groups, have students decide which natural resource card is theirs and report their findings to the class.

PART B

1 Display the following terms and definitions used in Part A: natural resources, oil, sandstone, bauxite, iron ore, trees. Add the following: renewable resource, non-renewable resource, fossil fuel, mineral, plant, animal. Review the definitions with students, perhaps having them record the definitions in their own words. They will use each of these terms in the next step to make a dichotomous key.

2 Give each student the handout, *Goods and Resources*. Explain to students that the chart on the handout is a dichotomous key, which provides a way to organize natural resources. Have students begin by placing terms in the spaces numbered 1-8. Instruct them that each of the four words under natural resources should be used twice in the answer spaces numbered 1-8. Provide further help to the students, depending on their previous experience with dichotomous keys.

ANSWERS to *Goods and Resources*:

1. & 2. trees and sheep (either order);
3. & 4. oil and bauxite (either order);
5. trees, 6. sheep, 7. bauxite, 8. oil.

3 Have students continue filling out the chart by providing additional examples of fossil fuels, minerals, plants and animals. Based on these examples, have students list products (return attention to the specific products brought into class) made from each of these under the heading, "Products." Have students add other products and brainstorm products for animals.

4 Ask students for another term for the word "product." It is the economic word "goods" used in the title of the handout.

5 While students look at the chart, ask them which natural resources are saved when the specific products on the list are recycled. (Rarely is a product made from 100 percent recycled

material, however, natural resources are conserved to the degree that recycled materials are used.) Ask students to identify two other ways that resources can also be conserved (reduction, reuse).

6 Engage students in groups (could be the same groups used in Part A) in a research project by having them use encyclopedias or on-line information sources to complete the handout, *The Nature of Natural Resources*. Review answers with students.

7 The information acquired in Step 6 can be used to make a new game with new clues that were not used in the first game.

Assessment

1 Give students a blank copy of the handout, *The Nature of Natural Resources*, and have them fill in the information for one of the products of their choice without using the completed version of the handout.

2 Based on the information gathered for the handout, *The Nature of Natural Resources*, have each student make up one clue card for each of the five product categories.

Student Handout

CLUE CARDS-1

2

Not all kinds of me can be recycled. For example, mirrors, light bulbs and windows should not be placed in recycling bins.

4

After writing on me, Americans throw so much of me away that we could build a 12-foot-high wall from New York to Los Angeles!

1

Americans throw away enough of me to rebuild our commercial airline fleet every three months.

3

It takes 1,800 of me to make a very heavy and colorful 6-foot picnic table.

Student Handout

CLUE CARDS-2



6



I can be recycled into many products: carpeting, clothing, cassette tapes, tennis balls and new containers for salad dressing, cough syrup, mouthwash and cleaning products.



8



Even though I may come in many colors, I can only be recycled when I'm brown, green or clear.



5



At the recycling center, it's easy to separate me from the other containers because of my "magnetic" personality.



7



Because of my grayish color, you'll often find me recycled into the inner layer of your cereal and cracker boxes.

Student Handout

CLUE CARDS-3


















Coffee and soup cans are just two items made from me.

10


















I've already been a soup can and now I'm a part of your new car.

12


















I've become a popular type of metal container because I'm strong but weigh very little.

9


















I'm used for packaging, and am especially good at holding dry goods, like cereal.

11

Student Handout

CLUE CARDS-4

14

It takes five of me to produce
enough fiberfill to stuff a ski
jacket or to make a T-shirt, and
25 of me to make a sweater.



16

After you read me on Sunday
mornings, don't throw me away.
When you recycle me, another
person can buy me at the store.



13

You'll often find me a hazard if
you're walking along the road or
in the woods because of my
broken and jagged edges. What
a shame, because I'm so easily
recycled.



15

Some products that used to be
made from steel, like beverage
cans, are now made out of me.



Student Handout

CLUE CARDS-5

18

More than 90 percent of all food cans are made from me.

20

Containers made from me have been around for 4,000 years.

17

Recycling me reduces energy use by as much as 95 percent.

19

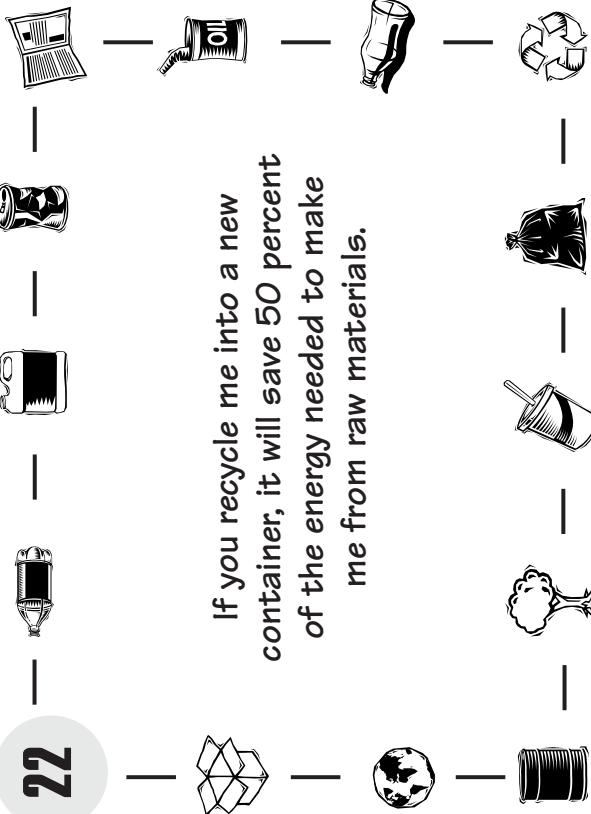
Every year, I'm used to replace body parts such as eyes, ears, elbows, hands, shoulders, hips, knees, legs, ankles or toes that are missing, injured or worn out.

Student Handout

CLUE CARDS-6

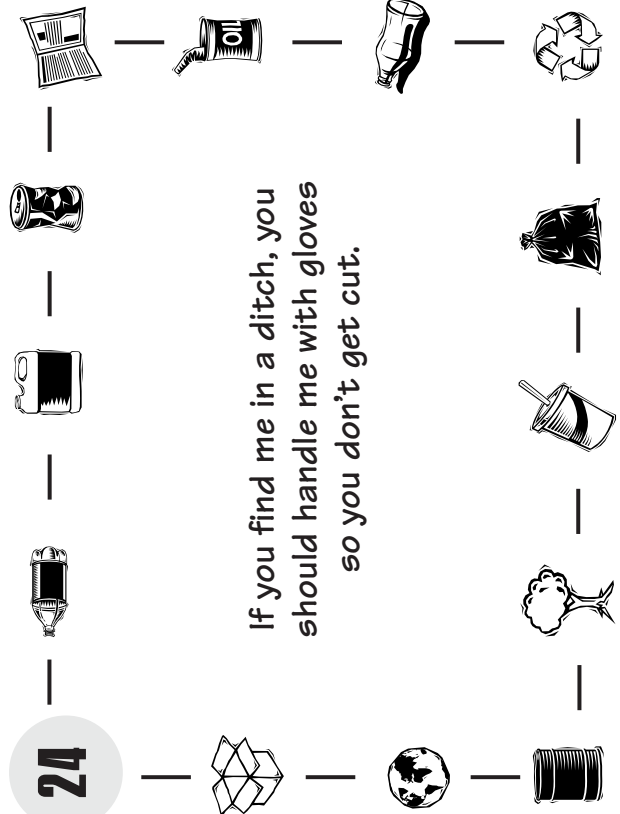
22

If you recycle me into a new container, it will save 50 percent of the energy needed to make me from raw materials.



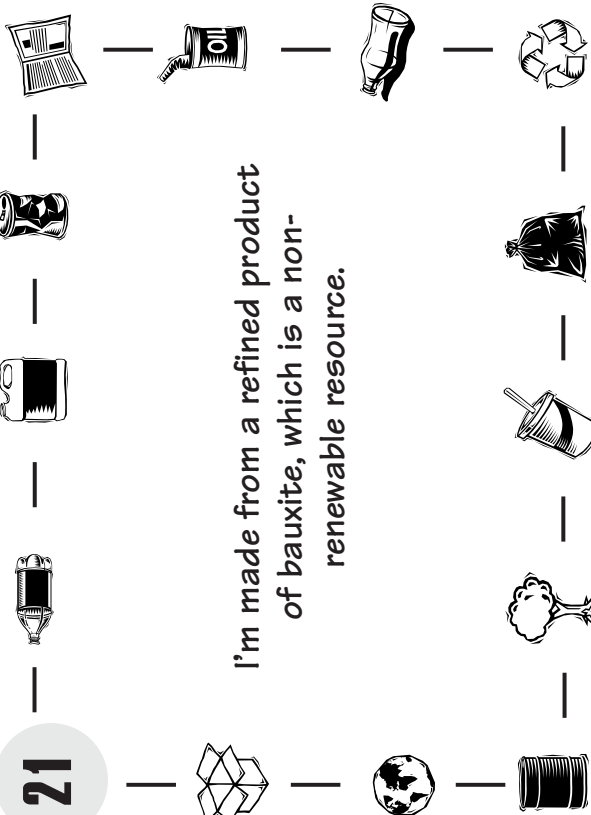
24

If you find me in a ditch, you should handle me with gloves so you don't get cut.



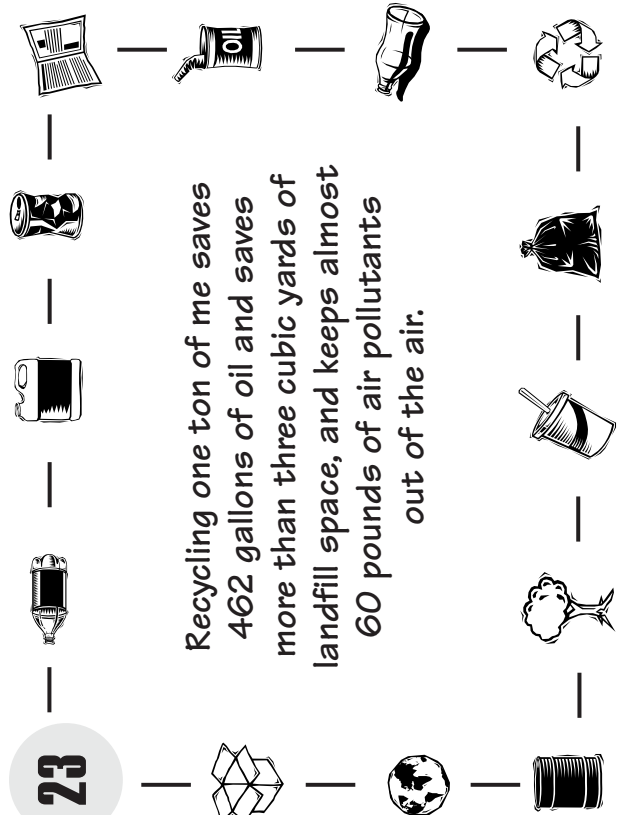
21

I'm made from a refined product of bauxite, which is a non-renewable resource.



23

Recycling one ton of me saves 462 gallons of oil and saves more than three cubic yards of landfill space, and keeps almost 60 pounds of air pollutants out of the air.



Student Handout

CLUE CARDS-7














26





Not only can I be recycled and made into plastic lumber, but I can also be made into recycling bins, milk jugs, flower pots and motor oil containers.














28





Even though I am easily recycled, people still throw me away more than any other recyclable material.














25





Recycling one ton of me saves mining more than 2,500 pounds of iron ore, 1,000 pounds of coal and 40 pounds of limestone.














27





Ohio is the second largest producer of me in the U.S. and Americans use about 100 million of me every day.

Student Handout

CLUE CARDS-8











I'm used to make wet suits, air hoses, masks, snorkels and fins that some divers and swimmers use.





















Making me requires tremendous amounts of electricity.









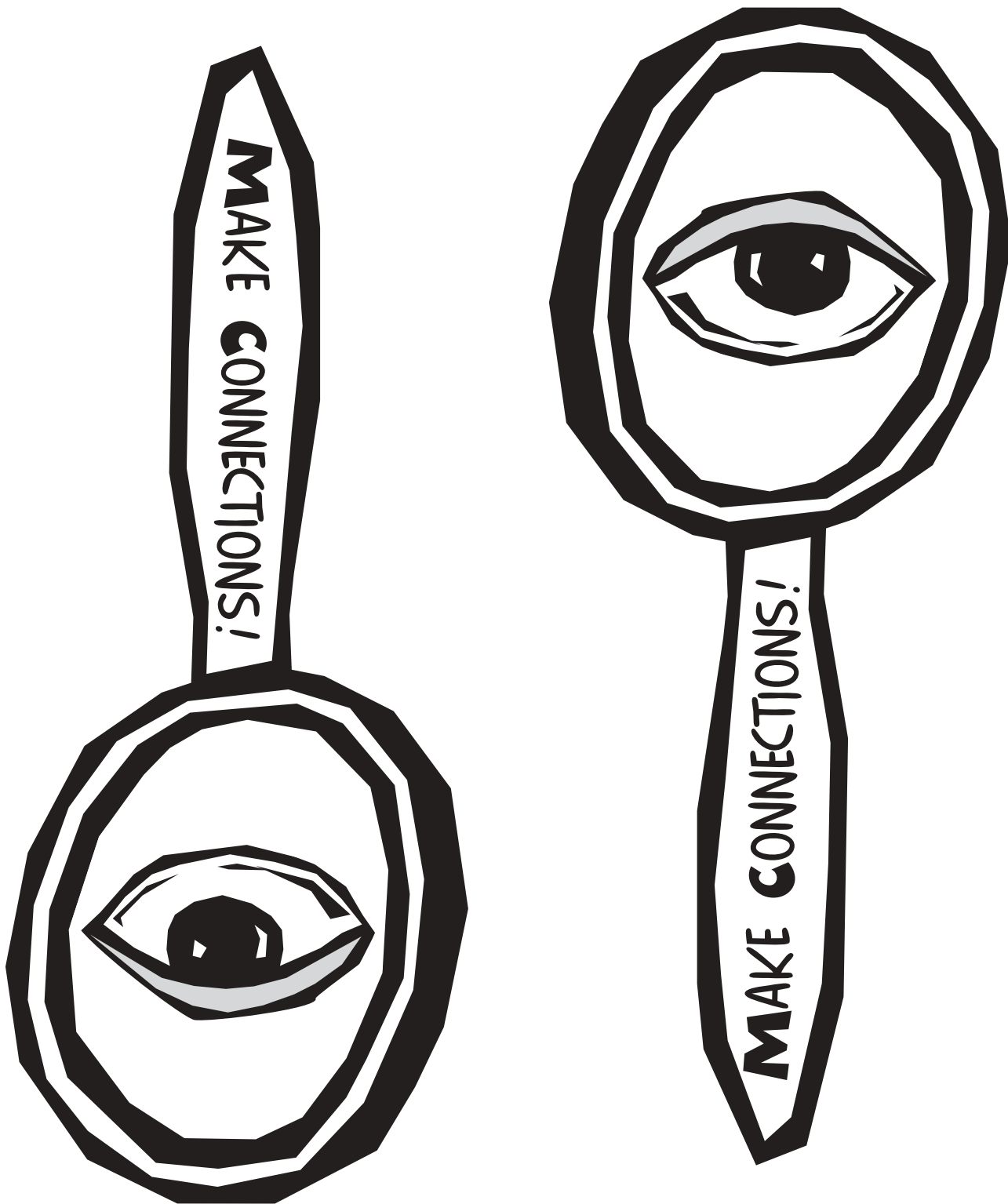


It's always a good idea to use both sides of me before putting me in the recycling container.

Student Handout

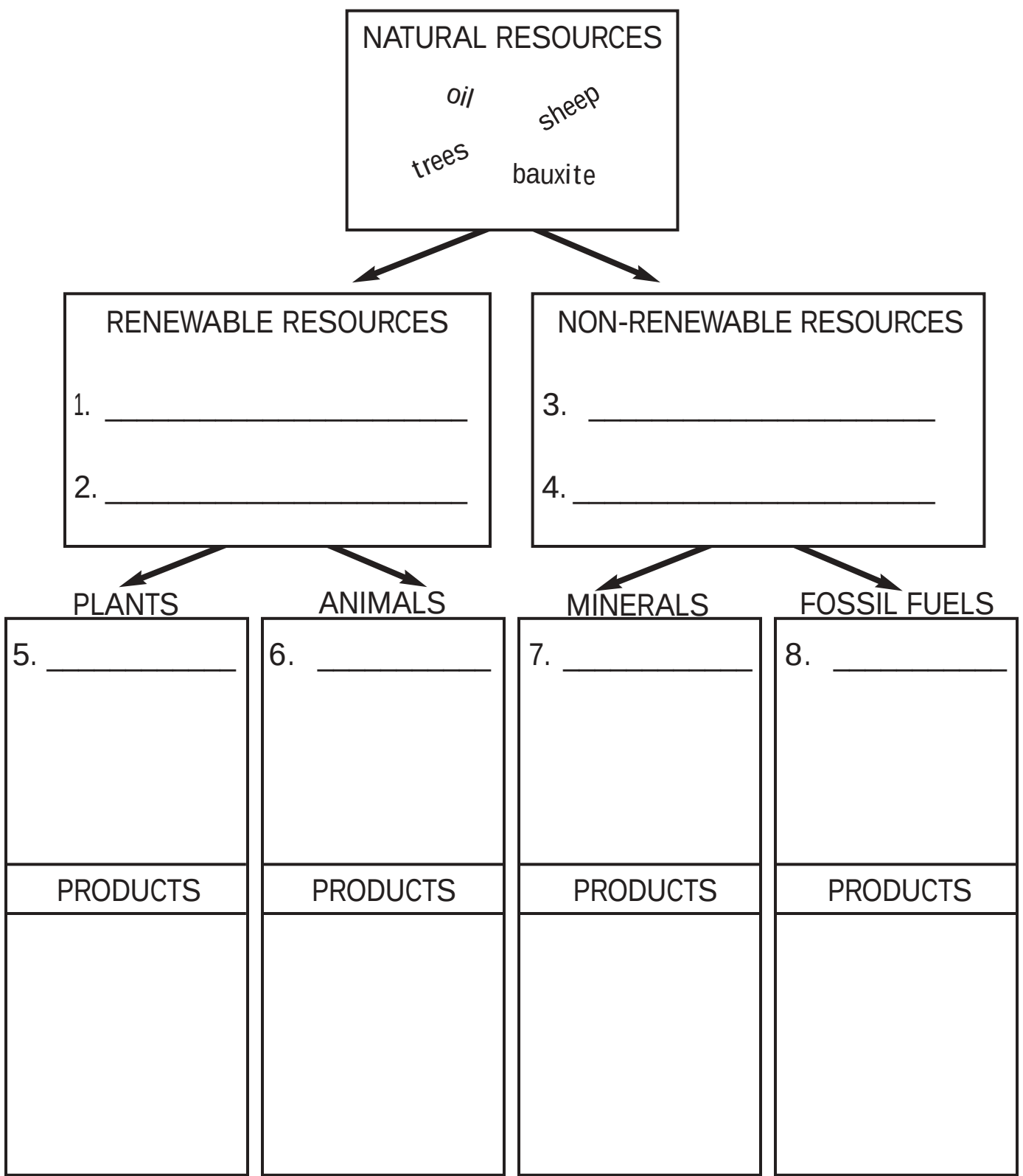


SUPER SLEUTH DETECTIVE LENS



Student Handout

GOODS AND RESOURCES



Student Handout

THE NATURE OF NATURAL RESOURCES

Directions: Complete the chart below.

PRODUCT MATERIAL	NATURAL RESOURCE	LOCATION Places on earth where the natural resource is mined or harvested.	USE Name three different products (finished goods) made from this resource.	CONSERVATION Identify three things you can do to conserve this natural resource.
Paper & Cardboard				
Aluminum				
Plastic				
Steel				
Glass				



Mining and Recycling

Objectives

Students will be able to: (a) describe how resources are extracted from the earth; (b) identify the effects of resource extraction on the environment in terms of land use and pollution; and (c) infer the ability of recycling to conserve resources and reduce the harmful effects resource extraction has on the environment.

Procedure

PART A

1 Prior to conducting the chocolate chip mining activity, have students complete the handout, *Things I “Gotta Have.”* Discuss with students why we mine (needs and wants) and what we mine. After students discuss their answers, ask them to research and then list on the back of the handout how their first choice was manufactured and what minerals, energy or metals were mined to make it.

2 Display the handout, *Know Your Minerals*, on an overhead projector. Ask students to count how many unfamiliar minerals and metals make a car. Which minerals and metals are found in common consumer products that can be recycled?

PART B

1 Divide the class into groups of four and pair up students in each group. Distribute materials. Before passing out the cookies, tell students:

DO NOT EAT THE CHOCOLATE CHIP COOKIE. Using an overhead projector, look at the handout, *Mining Activity Sheet*. Together, read through the sheet and define any terms that are unfamiliar, such as conglomerate, processing time, extracted, extruder, bankrupt, cost, earnings.

- 2** Write the following rules on the chalkboard:
- Your cookie will earn \$1,000 for every 2-cm. straw you fill with chocolate pieces.
 - You will be charged \$100 for every minute it takes to process your chocolate (remove all the crumbs).
 - The value of your cookie goes down \$100 just for digging into it. The more damage, the more you lose. The fine: \$100 for each cookie piece that breaks off.

- 3** Have students consider the following:
- What is the best way to extract the chocolate from the cookie?
 - Is it better to work in a group of four or form a conglomerate and combine

RESOURCE EXPEDITIONS

Inquiries

- How are resources extracted from the earth?
- What are the potential environmental consequences, both positive and negative, of mining?
- How does recycling lessen the demand for natural resources and protect the environment?

Content Domain

Math

Science—General science, earth science

Learning Outcomes

Math, Grade 4, #3, #8 and Grade 6, #3

Science, Grade 4, #14 and Grade 6, #4, #17

Duration

Part A: 60 minutes

Part B: 50 minutes

Materials

Chocolate chip cookies (one per student); **toothpicks** for use as extruders (one per student); **straws** cut into 2-cm. segments (several per student); **paper towels** (one per student); **overhead projector**

Handouts

- *Things I “Gotta Have”*
- *Know Your Minerals*
- *Mining Activity Sheet*

mining results? (This must be decided before students begin the actual mining process.)

Distribute an activity sheet to each group.

4 Share the following with students: Examine your cookie. How many chips can you see? Peek “underground” by looking at the bottom of the cookie. Predict how many straws your cookie will fill with chocolate. Also, predict how much money your cookie will earn. Write these figures on the activity sheet. Have your partner time your work. Using your extruder, carefully dig out the chocolate as your partner times your work. You must dig only from the top. Why? (Applications to real-life considerations: practicality, available technology, safety, expense.)

5 Share the following computation process for the handout, *Mining Activity Sheet*, with students.

- Figure land damage by counting the cookie pieces (if your cookie is still whole, count it as one piece) and record the total under “Land Damage.” Round off the time to the nearest minute and record it under “Processing Time.”
- Measure your chocolate by picking up the pieces with a 2-cm. straw. Fill as many straws as you need and record the number of straws under “Chocolate Extracted.”
- Figure your earnings on the activity sheet to find out how successful your digging was.

Questions for Discussion

- Whose cookie made money?
- Did anyone go bankrupt?
- Did your “conglomerate” bail you out?
- Why do you think you either made or lost money? (lots of chocolate, careful digging, good planning or lack thereof)
- If you were real miners, what would your cookie represent? (a mine)
- If the cookie is a mine, what is the chocolate? (gold, silver, iron ore, etc.)
- What do the pieces of cookie represent? (waste product, land damage)
- How do you think the process of mining affects the environment, both positively and negatively?
- What role do you believe mining companies can or should take in environmental stewardship?
- What does recycling have to do with all of this?
- How is recycling connected to resource management?
- How can recycling help reduce the harmful impacts of resource extraction?

Assessment

Completion of the handout, *Mining Activity Sheet*.

Student Handout

THINGS I "GOTTA HAVE"

Directions: Rank-order each of the consumer items listed below, #1 being the item you would be least willing to give up. There is a blank for your favorite item if it is not on the list.

_____ MICROWAVE OVEN	_____ SOAP	_____ BICYCLE
_____ TELEPHONE	_____ TELEVISION	_____ ALUMINUM CONTAINERS
_____ PERSONAL COMPUTER	_____ MILK	_____ CLEAN CLOTHES
_____ FISHING POLE	_____ DEODORANT	_____ CANDY
_____ WATCH	_____ LIGHT BULB	_____ TOOTHBRUSH
_____ HAIR DRYER	_____ CURRENT FASHION	_____ STEREO
_____ NEWSPAPER	_____	

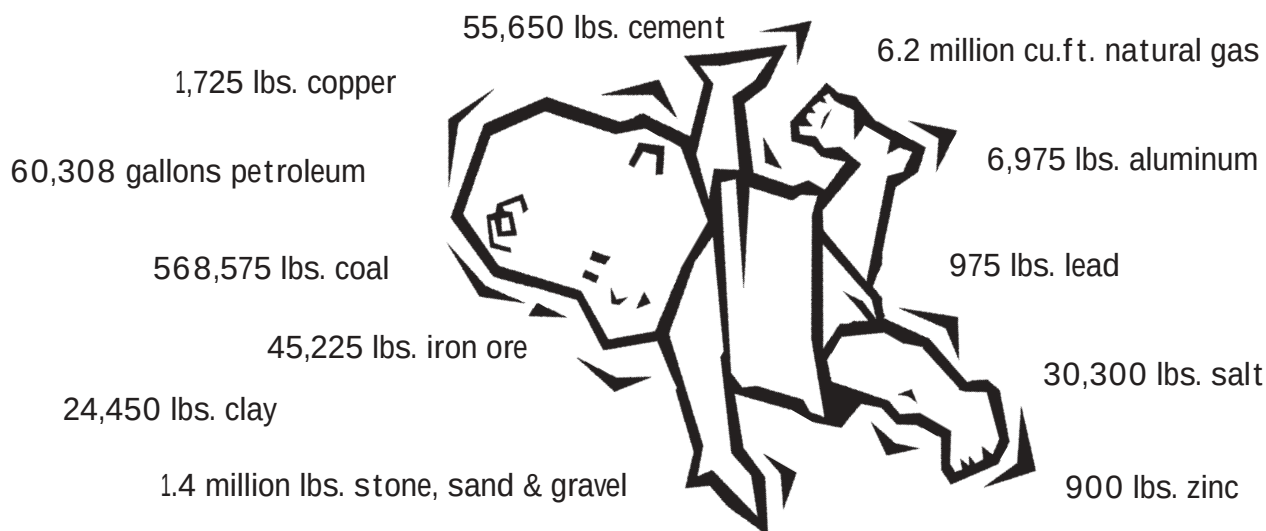
WHY DO WE MINE?

Because people need, want and sometimes demand the products made from minerals, metals and energy that come from the earth.

EVERYTHING IS MADE OF SOMETHING

When a person wants something, rarely does he or she think about the source of the materials needed to make that product. Everything tangible that you want or buy must be made of materials taken from our natural resources. Most of this material is from minerals, metals and petrochemicals.

Every American born will need...



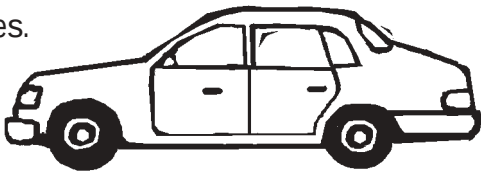
...3.5 million pounds of minerals, metals and fuels in a lifetime*

*Adapted from materials provided free to teachers from the Mineral Information Institute, web site: www.mii.org

KNOW YOUR MINERALS

More than 8 million new cars are made every year in the United States. In 1995, there were 133,929,661 cars in the United States.

The average weight of an automobile is 2,600-3,000 pounds. It is made by combining at least 39 different minerals and metals, each performing a special function when used in combination with the other.



Aluminum and steel figures overlap in some applications, such as the frame or engine, so the total weight of all components may exceed 3,000 pounds.

What's in a Car?

Material	Weight	Material	Weight
Aluminum	.240 lbs.	Mica	trace
Antimony	trace	Nickel	.9 lbs.
Asbestos	.66 to 1.2 lbs.	Niobium	<.5 lbs.
Barium	trace	Nitrogen	trace
Cadmium	trace	Palladium	trace
Carbon	.50 lbs.	Plastics	.250 lbs.
Cobalt	trace	Platinum	.05 to .1 troy oz.
Copper	.42 lbs.	Phosphorus	<1 lb.
Chromium	.15 lbs.	Potash	trace
Fluorspar	trace	Rubber	.140 lbs.
Gallium	trace	Sand	.89 lbs.
Gold	trace	Silicon	.41 lbs.
Graphite	trace	Strontium	trace
Halite	trace	Sulfur	.2 lbs.
Iron/Steel	.2,124 lbs.	Tin	trace
Lead	.24 lbs.	Titanium	trace
Limestone	trace	Tungsten	trace
Magnesium	.4.5 lbs.	Vanadium	<1 lb.
Manganese	.17 lbs.	Zinc	.22 lbs.
Molybdenum	.1 lb.	Zirconium	trace

* Adapted from materials provided free to teachers from the Mineral Information Institute, web site: www.mii.org.

Student Handout

MINING ACTIVITY SHEET

PREDICTING

How many straws do you think you will fill? _____

How much money do you think you will make? _____

Will your group need to work as a conglomerate? YES NO

HOW TO FIGURE YOUR EARNINGS

- Your cookie will earn \$1,000 for every 2-cm straw you fill with chocolate pieces.
- You will be charged \$100 for every minute it takes to process your chocolate (remove all the crumbs).
- The value of your cookie goes down \$100 just for digging into it. The more damage, the more you lose. The fine: \$100 for each cookie piece that breaks off.

Fill in your scores and multiply to get the total amount.

STEP 1

LAND DAMAGE (see above) _____ pieces x \$100 = \$ _____

PROCESSING TIME _____ minutes x \$100 = \$ _____

Add dollar values for the PROCESSING TIME and LAND DAMAGE

TOTAL COSTS: \$ _____

STEP 2

CHOCOLATE EXTRACTED _____ straws x \$1,000 = \$ _____

Are the TOTAL COSTS (Step 1) more than the dollar value of your CHOCOLATE EXTRACTED (Step 2)?

YES Your mine has lost money. Write **BANKRUPT** below.

NO Subtract the TOTAL COSTS from the CHOCOLATE EXTRACTED

Write answer below.

TOTAL EARNINGS: \$ _____

TOTAL CONGLOMERATE EARNINGS: \$ _____
(if you chose in the beginning to work as a conglomerate)

GOING GLOBAL

Environmental Studies Learning Concept

People of the world consume disproportionate amounts of the Earth's resources due to inequitable geographic distribution of resources and variations of wealth within societies and among nations. As nations continue to develop, there will be a greater demand for world resources, thus increasing the need for the efficient use of these resources, including solid waste.

Recycling is part of world trade as secondary materials are bought and sold in world markets. Recycling and reuse also promotes national self-sufficiency by reducing the need for a country to obtain resources from another country.

Just as countries possess and acquire different amounts of resources for raw materials and energy, countries differ in their use of secondary materials and in their solid waste management practices. Solid waste management practices often reflect the development status of a country as a consumer economy, which is an important factor in the types and amounts of waste generated. Some countries are more efficient at recycling and reusing waste materials than others.

Vocabulary

composting – a waste management alternative whereby organic wastes are partially decomposed by microorganisms (bacteria and fungi) to produce a humus or soil-like product

garbage – refuse, or solid waste, consisting of food wastes; animal and vegetable wastes resulting from handling, storage, sale, preparation, cooking and serving of foods; in technical terms it is distinguished from trash and rubbish; but in common usage it is a synonym for all refuse, including trash and rubbish

incineration – an engineered combustion (or burning process) to thermally reduce the quantity of waste materials into gases and relatively small amounts of ash; offers potential for energy recovery

landfill – large, outdoor area for waste disposal; in sanitary landfills, waste is spread on land and compacted in layers and covered with soil or other materials daily

municipal solid waste – includes non-hazardous waste and very small quantities of household hazardous waste generated in households, commercial and business establishments, institutions and light industrial process wastes; it is often contrasted with hazardous waste that requires disposal in permitted hazardous waste disposal sites

non-renewable resource – a natural resource that is not capable of being naturally restored; it is either a finite amount in the Earth's crust, or cannot be replenished because it is replaced more slowly than it is used

primary material – virgin, raw materials used for manufacturing basic products, such as wood chips, iron ore, silica sand and bauxite.

recycling – the act of collecting and separating materials and products from the solid waste stream and reusing them as raw materials in manufacturing processes

renewable resource – a naturally-occurring material or form of energy, such as the sun, wind, falling water, biofuels, fish and trees; it is derived from an endless or cyclical source, where, through management of natural means, replacement roughly equals consumption

rubbish – solid waste (excluding ashes and food waste), consisting of both combustible and non-combustible waste materials

secondary material – commercial products recovered from the waste stream for reprocessing and remanufacturing; includes material from municipal solid waste streams and waste materials from manufacturing or conversion processes

Overview - GOING GLOBAL



Activity 1: From Ohio to the World... From the World to Ohio

Description

Students *conduct research* about the top 10 countries Ohio imports products and resources from and *organize information* to make classroom presentations. The class *makes decisions* to construct a booklet from this information. Countries are located by using a global map and connected to Ohio with string and directional arrows.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #7 – Demonstrate map skills by: (b) locating major land formations and bodies of water or (c) using a number or letter grid system to locate places on a map, a map key to understand map symbols, a linear scale to measure distances on a map and a direction finder.

Grade 4, Reading #19 – Choose materials related to purposes, as evidenced in part by the capacity to: (a) choose or identify library resources to locate specific information, and (b) choose appropriate resources and materials to solve problems and make decisions.

Grade 6, Citizenship #9 – Interpret and analyze maps, charts or graphs to formulate geographic ideas.

Grade 6, Citizenship #15 – Use information about global resource distribution to make generalizations about why nations engage in international trade.

Summary

This lesson includes three activities. They can be done separately, however the first activity provides a good background for the second activity. The third activity is independent of the first two activities.

Activity 2: I Need This...Do You Have Some?

Description

Students *work cooperatively* to identify some of the resources that are used to make an item. They *make inferences* to identify whether it was produced from renewable or non-renewable resources, primary or secondary materials or mixed materials.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #11 – Name the resources needed to produce various goods and services.

Grade 6, Citizenship #15 – Use information about global resource distribution to make generalizations about why nations engage in international trade.

Activity 3: Trash Around the World

Description

Students *analyze* information found on different types of graphs and *make inferences* about the solid waste handling practices of different countries.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #24 – Make or use a table to record and sort information, and make identifications, comparisons and predictions from tables, picture graphs, bar graphs and labeled picture maps.

Grade 6, Mathematics #22 – Read, interpret and use tables, charts, maps and graphs to identify patterns, note trends and draw conclusions.

Background Information

World markets for raw materials, food and manufactured goods link national economic systems.

People of the world consume disproportionate amounts of the earth's resources due to the inequitable geographic distribution of resources and wealth within societies and among nations. As nations develop, there will be a greater demand for world resources thus increasing the need for the efficient use of these resources.

Recycling is part of world trade as **secondary materials** are bought and sold in world markets. Secondary materials are those resources derived from the waste stream as opposed to **primary materials**, which are produced, from **renewable** or

non-renewable resources taken directly from nature. Secondary materials markets are as volatile as global trade markets for primary materials and products. The scrap metal industry of the Great Lakes region provides a good example. In 1986, 13 million tons of scrap metal was exported from the Great Lakes ports. Since 1994 that average has fallen to less than 50,000 tons.

The domestic aluminum can market suffered similarly in 1998. The prices paid for aluminum cans fell. This was caused by what has been called the "triple ripple" effect. First, Asian countries purchased less durable goods made in the U.S., such as airplanes. Second, Asian countries shipped more goods made of aluminum into American markets. Finally, Asian demand for U.S. scrap aluminum was low. The result was that aluminum, which should have been exported, was available for sale

on the domestic market. This surplus of aluminum in the U.S. resulted in lower prices for recycled aluminum cans.

Trade, both national and international, is very important to Ohio because it is a leading exporter. For example, Ohio companies exported to 191 foreign destinations in 1994.

Ohio's leading export industries include transportation, equipment, industrial machinery/computer equipment, chemicals and allied products, electronic equipment, fabricated metal products, and rubber and plastic products.

The Cleveland Ohio Customs District further breaks down these industries into categories of products. Below are lists of the types of products being exported and imported through the Cleveland Ohio Customs District. The Cleveland Ohio Customs District encompasses all of Ohio and parts of Indiana and Kentucky.

Examples of Ohio's Natural Resource Exports and Imports

Exports

- Oil – for refining as lubricants
- Sandstone
- Peat
- Clay
- Gypsum
- Shale
- Coal – high-sulfur
- Sand and gravel
- Limestone and dolomite
- Fish
- Salt – for road de-icing and table

Imports

- Iron ore – for iron and steel
- Bauxite – for aluminum
- Coal – low sulfur
- Oil – for refining as fuel
- Natural gas*
- Marble and granite
- Rubber
- Timber*— for wood products and paper

** Although Ohio produces much of its own supply of these resources, additional supplies must be imported — Ohio Department of Development*

The top 10 categories of products exported out of Ohio**

1. electric machinery, sound equipment, TV equipment and parts
2. nuclear reactors, boilers, machinery and parts
3. optic, photo equipment, medical or surgical instruments, etc.
4. aircraft, spacecraft and parts
5. precious stones, precious metals, coins
6. mineral fuel, oil, bituminous substances, mineral wax
7. cereals
8. pharmaceutical products
9. oil seeds, miscellaneous grain seeds, fruit, plants
10. miscellaneous chemical products

The top 10 categories of products imported into Ohio**

1. nuclear reactors, boilers, machinery and parts
2. electric machinery, sound equipment, TV equipment and parts
3. vehicles and parts except railway or tramway
4. apparel articles and accessories, knit or crochet
5. apparel articles and accessories, not knit or crochet
6. optic, photo equipment, medical or surgical instruments, etc.
7. iron and steel
8. toys, games and sports equipment, parts and accessories
9. articles of steel or iron
10. aircraft, spacecraft and parts

*** Massachusetts Institute for Social and Economic Research State Data Center*

Just as countries possess and acquire different amounts of resources for raw materials and energy, countries differ in solid waste management practices. Physical size, climate and population of a country influence these practices. A country may choose to utilize **landfilling**, **incineration**, **composting** and/or **recycling**. Some countries generate less waste and are more efficient at recycling and reusing waste materials than others.

When comparing the solid waste statistics provided by different countries, it is important to remember that every country has its own standard for reporting solid waste statistics. According to the March 1998 issue of the *Warmer Bulletin*, in Japan, an unknown amount of recycled waste, especially paper, is collected by private sector recyclers. Since privately collected amounts are not counted in official solid waste statistics, Japan's recycling figures are artificially low.

The amount and composition of waste generated in each country is directly related to urbanization, the types and patterns of consumption, household revenue, and lifestyle of its population.

Listed below is further information about the countries included in the activity handout.

Bibliography and Additional Resources

Educator Information

For more information on Ohio as an international trade partner, contact: Ohio Department of Development, International Trade Division, 77 South High St., Columbus, OH 43266-0413 or visit their website at: www.ohio.trade.tpusa.com.

Recycling Today, January 1998

Recycling Today, March 1998

Internet

Solid waste data is often compiled differently by each country. A variety of international solid waste information can be found on the Internet. One good site is the Australian Waste Database at: www.civeng.unsw.edu.au/water/awd/awdb2.html. This site has links to the waste databases of many other countries.

The U. S. EPA also maintains a website with good solid waste statistical information for the United States and many other countries.

www.epa.gov/epaoswer/non-hw/muncpl/factbook.htm.

Warmer Bulletin, an international magazine published by The World Resource Foundation in Tonbridge, Kent, England contains international solid waste information. The World Resource Foundation also maintains a website at www.wrf.org.uk.

Vital Statistics

Country	Population	Per Capita GDP*	Land Size (sq. miles)	Population Density (per sq. mile)
Canada	29,123,194	\$24,400	3,849,674	.8
France	58,040,230	\$18,670	210,026	.276
Germany	84,068,216	\$17,900	137,830	.610
Japan	125,716,637	\$21,300	145,850	.861
USA	267,954,767	\$27,607	3,675,031	.72

*Gross Domestic Product

1998 World Almanac and Book of Facts, World Almanac Books

GOING GLOBAL

Activity
1

From Ohio to the World... From the World to Ohio

Inquiries

- Which countries are Ohio's trade partners?
- Which countries are the citizens of Ohio most dependent upon for natural resources?
- Why is it important for Ohio to trade resources and products?

Content Domain

Language Arts – Reading
Social Studies – Geography

Learning Outcomes

Citizenship, Grade 4, #7 and
Grade 6, #9, #15

Reading, Grade 4, #19

Duration

45-60 minutes

Materials

Global map that students can stick pins into or put tape on,
string, small cardboard arrows, push pins, tape

Objectives

Students will be able to: (a) locate countries on a global map and (b) distinguish between export and import, and explain the importance of global trade for the world and Ohio.

Background Information

Ohio export and import information is compiled by the Cleveland Ohio Customs District. This district encompasses all of Ohio and parts of Indiana and Kentucky.

The top 10 countries importing products or resources into the State of Ohio:

Canada	Hong Kong
China (Mainland)	Japan
China (Taiwan)	Korea
France	Singapore
Germany	United Kingdom

The top 10 countries the State of Ohio exports products or resources to:

Australia	Germany
Belgium	Japan
Canada	Korea
China (Taiwan)	Mexico
France	United Kingdom

Ohio Department of Development, International Trade Division, December 1996

Preparation

Hang a world map in an area where all students can see it and have access to it. If a map is not available, create one from a large piece of corrugated cardboard or paper that can be glued, pinned or otherwise added to. The map should include a key indicating mileage.

Whichever map is chosen (prepared or purchased), there should be room on

the map or bulletin board for a legend explaining all of the information on the map. This map could hang in the classroom for an extended period. Different items could be added to it as students study other areas of the world.

Assemble reference materials for student use, such as a world almanac, Ohio almanac, encyclopedias and/or books about the nations that export to Ohio.

Procedure

1 If the global map being used does not include an outline of Ohio, it should be added.

2 Divide students into 10 groups. Assign each group one importing country and one exporting country. Each group should connect their countries to the state of Ohio with color-coded string and small cardboard directional arrows. The map's legend should include a key showing the coding systems. For example, one color of string or directional arrows for export and one for import. Students should use the map key to estimate how many miles their countries are from Ohio.

3 The class will prepare a booklet on Ohio's connection to the world using the import countries they were assigned. Each group will contribute two pages that include the following information:

- a map of the importing country and a picture of its flag
- a list of some of the country's natural resources
- a list of products the country exports (can be illustrated)
- one fact students learned about their country that they didn't know before

A good source for comparing statistics on different countries is the United Nations Internet site (www.un.org). Other sources students could use include encyclopedias, Ohio almanac or world almanac.

4 After all the groups are done, have each group report to the class about the resources of their assigned country. The students could put a list of the resources on the board. The pages the students prepared should be

compiled and assembled into a book. All students should be able to look at the finished book.

Discussion Questions

- Why is it important for Ohio to trade with other nations?
- What resources or goods do the importing countries have that you think we would want in Ohio as consumers and why?
- Can you think of things you use that come from other countries?
- How far do resources and products have to travel to get to Ohio from the different countries?
- What types of physical barriers (mountains, deserts, oceans) have to be crossed?

Assessment

- 1** Student participation in classroom discussions.
- 2** Group pages. Score based on a rubric scheme.
- 3** Individual student response to the booklet. After the discussion, and after the students have reviewed the booklet, ask students to select three nations they didn't work on and use the examples of those nations to explain what it means to be "connected with another part of the world." Score this assignment based on a rubric scheme. Consider the elements below for the rubric.

3 points- the student uses three different examples and shares a clear understanding of how the examples show connections.

2 points- the student uses three different examples and shares an ade-

quate understanding of how the examples show connections.

1 point- the student uses at least two different examples and shares an adequate understanding of how the examples show connections OR the student uses three different examples but shares an inadequate understanding of how the examples show connections.

0 points- the student uses at least two different examples but shares an inadequate understanding of how the examples show connections OR the student discusses only one example.

Extension

An extra large global map is mapped out using a playground. Students stand on the importing/exporting countries and connect to a student representing Ohio with colored string or rope.

GOING GLOBAL

Activity
2I Need This...
Do You Have Some?

Inquiries

- What natural resources are used to make everyday items?
- Which resources are renewable and which are non-renewable?
- What types of secondary material can be used in products?
- Which countries do some of our consumer goods come from?
- What can we do to conserve natural resources?

Content Domain

Social Studies – Geography

Learning Outcomes

Citizenship, Grade 4, #11 and Grade 6, #15

Duration

60-120 minutes

Materials

Several **products** that list the country of manufacture including some items that list “recycled content” on either the packaging or on the item or pictures of products, **drawing paper, glue, scissors, pins**

Handout

- *I Need This...Do You Have Some?*

Objectives

Students will be able to: (a) cooperate in groups to make inferences about the type of materials and resources that are used to manufacture products and (b) identify a product and the country in which it was manufactured.

Background Information

Natural resources are either **renewable** or **non-renewable** and can serve as either sources of energy or raw materials when manufacturing consumer products. A renewable resource is a naturally-occurring material or form of energy, such as the sun, wind, falling water, fish and trees. It is important to remember that even some renewable resources can be depleted. A non-renewable resource is not capable of being naturally restored. It is either a finite amount in the Earth's crust, or cannot be replenished because it is replaced more slowly than it is used.

The raw materials used for manufacturing can be either **primary materials** or **secondary materials**. Primary materials are resources (renewable or non-renewable) taken directly from nature. Secondary materials are collected from the waste stream to be reused. Secondary materials are often collected through recycling programs. The use of secondary materials in place of primary materials defers the need to extract resources from nature, as well as reduces a country's need to import natural resources from another country.

Below is a list of common items and the natural resources used to manufacture them.

Stereo

case – oil
tape – chromium, iron, oil
paint – chromium, oil

Computer

case – oil, iron
wires – copper, gold
circuit board – clay
monitor – rare earth, silica sand

Car

engine – iron or aluminum
exhaust system – lead
trim – chromium, zinc
gasoline – oil
battery – lead

Jewelry

metal – gold, silver, platinum
molds – silica sand, chromium
stones – gem
heat – oil, gas, coal

Camera

film – silver, oil
body – aluminum, iron
strap – oil
lenses – silica sand, salts
paper – clay, trees

Money

coins – iron, zinc, copper
paper – clay, trees
ink – oil
molds – iron, chromium, nickel

Preparation

Make one copy of the handout, *I Need This...Do You Have Some?*, for each student.

Procedure

1 Discuss with students the following terms: renewable, non-renewable, primary resources and secondary resources.

2 Divide students into groups. Each group should receive one or more products (or picture of products) to examine. The group should identify what resources the item(s) were made from and determine whether the resources are renewable or non-renewable, and primary or secondary.

3 Each group should list the information they compiled about their item on the board. As a class, discuss the choices the groups made.

- Why are most products made from primary as opposed to secondary resources? (Easier to get primary resources, it's always been done this way, subsidies for primary resource industries, having to retool manufacturing equipment to use secondary materials, unreliable market for purchasing recycled materials, contamination of recycled materials,

increased cost of items using recycled-content materials, etc.)

- What can we do to promote the use of secondary resources? (Recycle properly, purchase items made from recycled materials, etc.)

4 Each student will select one item they use that was imported from another country. Have students complete the handout, *I Need This...Do You Have Some?* The illustration below is an example of a bicycle resource web. Identify for the students the secondary resources that could be used in place of the primary resources. For example: wheel – aluminum cans, frame – steel cans, junk cars. Look at the students' webs and discuss as a class which secondary items could be used as substitutes for primary materials.

5 After each student has completed their handout, ask them to locate the exporting country (of their item) and pin (or glue) a small picture or drawing of it onto the global map created in the first activity.

6 Allow students time to look at the map and see the different items and countries that have been added.

7 Discuss the questions on the handout, *I Need This...Do You Have Some?* Also, discuss the following:

- Is the item you selected something you need or is it something you want?
- What would happen if everyone in the world wanted one of your item? What would happen if one of the natural resources needed to make your item was no longer available?
- Could your item be changed to use secondary materials rather than primary resources?
- Is it fair that someone living in the country that made your item may never be able to afford it?
- What happens to your item when you don't need it, want it or can't use it anymore?

Assessment

1 Participation in classroom and small group activity.

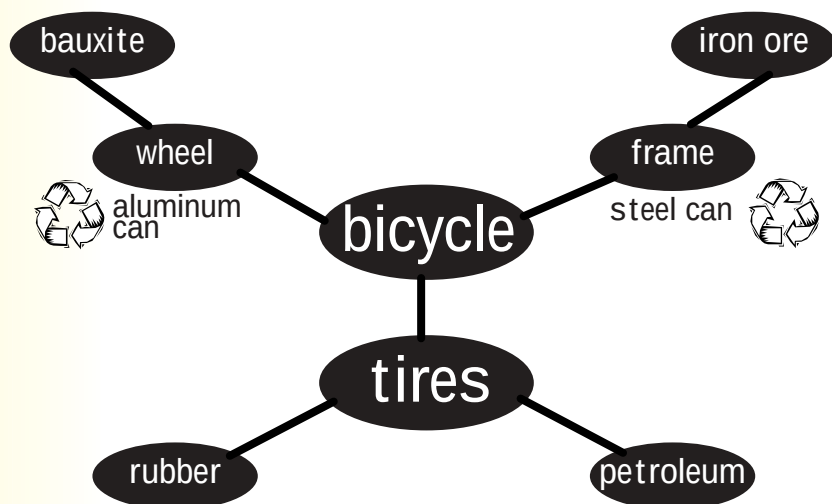
2 Completion of the handout, *I Need This...Do You Have Some?*

3 Suggested test questions:

- Define the following terms: renewable, non-renewable, primary resources and secondary resources.
- List some of the resources that are used to make a specific item.
- List one item that is a want and one item that is a need and explain why you chose them.
- What are some of the ways we can reduce the amount of natural resources used?

Extension

Have students research the different items that can be recycled in your community, as well as how these items should be prepared. Your local solid waste district will be able to provide this information.



Student Handout

I NEED THIS...DO YOU HAVE SOME?

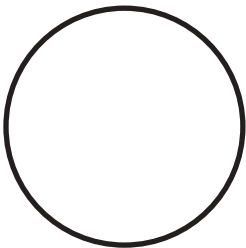
1. Think of a favorite object. It could be a toy, tool, machine or another item that you like. Check and see what country it may have been imported from (there should be a label or sticker on the item that identifies which country manufactured it). Draw a picture of the item in the circle below.

My item is _____ and it was made in _____.

2. List all of the parts to your item. (For example: a camera – body, strap, lens). Then list which natural resources were used to make the parts. Decide if they are renewable or non-renewable. Finally, decide if the part was made from a primary or secondary material.

Part	Resource	Renewable	Non-Renewable	Primary Material	Secondary Material

3. Make a web of the above information.





Trash Around the World

Objectives

Students will be able to: (a) interpret graphs and data about global solid waste concerns and (b) explain the relationships between a country's physical geography, per capita income, population and solid waste disposal methods.

Preparation

Post the comparison statistics of the different countries (included in the Background Information on p. IX-5) where all students can see them.

Copy one set of handouts per student or group of students.

On an average, 4.4 pounds of trash is what each person in Ohio throws out per day. Fill a clear plastic bag with 4.4 pounds of dry household waste. The bag should include items such as food jars and cans, paper, used clothing, cereal boxes, soda pop cans, toys, assorted plastic products, etc. Be sure to include products representing the seven (#1-7) different plastic codes. (This numeric code is located inside recycling arrows near or on the bottom of the container. The number represents a type of plastic. Most communities only accept items made from #1 and #2 plastic.) The garbage should include items that can be recycled locally as well as those that can't. During the activity the students will be handling this garbage; **please do not include any wet or unsanitary items.** All former food containers should be cleaned out and checked for sharp edges.

Determine what types of materials can be recycled in your community.

Procedure

1 Show students the bag filled with garbage. Explain to students that what they see is the household equivalent to the amount of waste each person throws out everyday. Explain that the volume may differ because the bag only contains dry waste. Ask students to visualize everything they have thrown out that day.

2 Explain to students that what you are showing them is an example of municipal solid waste. Define the terms rubbish and garbage. Discuss with students the types of items that are recyclable in their community, and how some things could be reused rather than thrown away.

3 Divide students into groups and give each group a small amount of the garbage from the bag. Explain to students that the garbage they have been given is "clean." If they were handling actual garbage, they would have to wear heavy gloves. Have each group tell the class whether their item(s) could be

Inquiries

- How do countries manage their solid waste in comparison with the United States?
- Why do the citizens of some countries throw out more trash than others?
- What factors affect a country's waste management practices?

Content Domain

Math – Arithmetic

Social Studies – Geography

Learning Outcomes

Math, Grade 4, #24 and Grade 6, #22

Duration

60-120 minutes

Materials

Bag of clean, dry garbage weighing 4.4 pounds. (The garbage should be placed in a **clear garbage bag.**)

Handouts

- *Tell Me About Your Trash Graphs*
- *Tell Me About Your Trash Worksheet*
- *Trash Around the World Assessment*

recycled or reused. If not, have students tell how the item would be disposed of in their community (i.e. landfilled or incinerated). Students should be told that not everything can be recycled or reused and that communities will always need landfills and/or incineration plants.

4 Each student should receive a copy of the handouts, *Tell Me About Your Trash Graphs* and *Tell Me About Your Trash Worksheet*. Ask students to look at the amount of waste thrown away per day by other countries. Discuss reasons why these amounts vary by country (per capita income, lifestyle, etc.).

5 Students can complete handouts by working individually or in groups.

6 Review with students the comparison statistics included in the Background Information on p. IX-5. Through discussion, have students correlate this information with the information provided on the graphs.

Discussion Questions

- Why would a country choose one way of getting rid of their trash as opposed to another? (Size of the country, land space available, population density, etc.)
- Why do you think Japan relies more on incineration? (Scarcity of land space, high population density, etc.)

Assessment

Assessment of student understanding can be done in two ways:

1 Through completion of the handout, *Tell Me About Your Trash Worksheet*.

2 Through completion of the assessment handout, *Trash Around the World*. The questions on this handout are modeled after the State Competency Based Education Assessment Series- Mathematics. Scoring for this handout is as follows:

QUESTION 1 - Sample Rubric

0 points- nothing is done, except to recopy part or all of the problem.

1 point- One valid conclusion or interpretation is made with no supporting discussion, OR there is some discussion, but no conclusion is drawn.

2 points- Two valid conclusions or interpretations are given, but there is no discussion, OR only one valid conclusion or interpretation is given with complete supporting discussion.

3 points- Two valid conclusions or interpretations are given, discussion is present but incomplete OR more than two valid conclusions or interpretations are given, but there is no or incomplete discussion.

4 points- At least two valid conclusions or interpretations are given with supporting discussion.

QUESTION 2

ANSWER: C – yard waste

QUESTION 3 - Sample Rubric

0 points- no work done or recopying of problem, incorrect division of circle.

1 point- corrects division of circle, no labeling, OR labeling and partially correct division.

2 points- correct division and labeling.

Extensions

1 Each year, Ohio's solid waste districts are required to submit a report to the Ohio Environmental Protection Agency outlining the different types and tonnage of recyclables that were collected. The solid waste districts are also responsible for tracking where and how that district's solid waste is disposed. Students could contact their local district and then contrast district information with state, national and international figures.

2 Through research, determine how another country disposes of its trash and how much trash is thrown away per person. This research could be done by searching the Internet, or by sending an email or letter to the country's environmental agency(s).

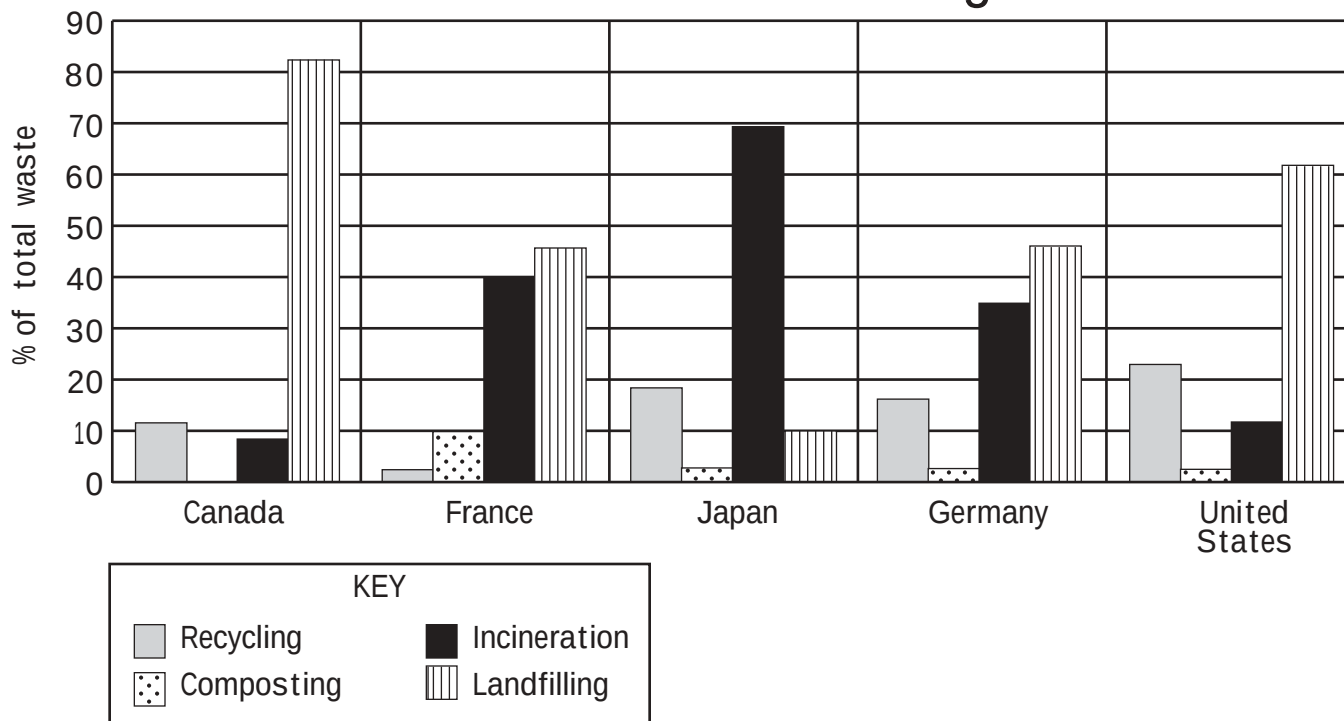
3 Research how different countries or states determine their recycling rates. Every country and/or state may have its own reporting method, which can make comparing statistical recycling rates misleading.

Student Handout

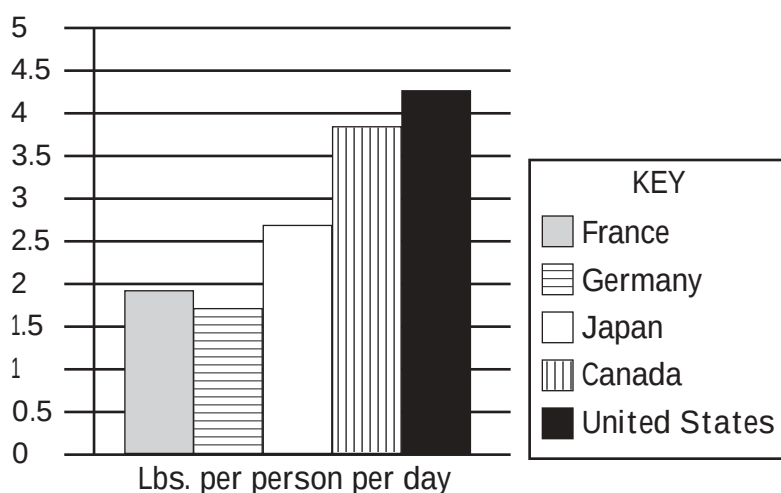


TELL ME ABOUT YOUR TRASH GRAPHS

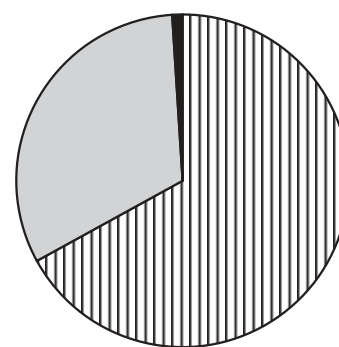
Where does our trash go?



How much trash do we throw out every day?



What do people in Ohio do with their trash?



1997 Ohio Solid Waste Facility Report, Ohio EPA.
 Note: The MSW Factbook, Ver.4, Office of Solid Waste, U.S. EPA, 1997, reports Ohio's recycling rate at 15%, with 83% landfilled.

MSW Factbook, Ver. 4, Office of Solid Waste, U.S. EPA, Washington DC, 1997

Student Handout

TELL ME ABOUT YOUR TRASH WORKSHEET

Directions: Look at the graphs and answer the following questions.

1. Which country uses a landfill the most to dispose of its trash? _____
2. On the same graph, which country recycles the most materials? _____
3. Who uses a landfill more to dispose of their trash—people in Ohio or Japan? _____
4. Who throws out the most trash per day? _____
5. Who throws out more trash per day- people in Japan or Canada? _____
6. What percentage of waste is incinerated in Japan? _____
7. How many pounds of trash does the average person in the United States
throw out per day? _____
8. What percent of the trash in France is composted? _____
9. Who does more recycling- people in Ohio or France? _____
10. What percentage of trash in Germany is recycled? _____

Student Handout

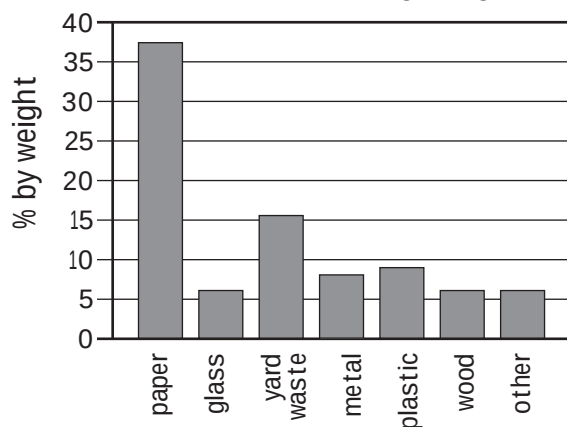


TRASH AROUND THE WORLD

- 1** People in different countries throw out different amounts of waste every day. To the right is a list of how much is thrown out in four different countries. Write a paragraph about two conclusions you can draw from the information. Justify your conclusions.

COUNTRY	TRASH RECYCLED	TRASH LANDFILLED
Spain	13%	64%
Sweden	16%	32%
Netherlands	16%	48%
United States	23%	61%

What's in the U.S.'s garbage?

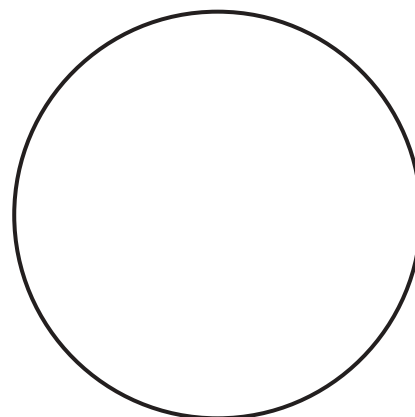


- 2** Which item is nearly one-half the amount of paper generated in the U.S.'s garbage?
- a. metal
 - b. plastic
 - c. yard waste
 - d. other

- 3** What's in Switzerland's trash?

TYPE OF WASTE	PERCENT OF WASTE
Paper	33%
Plastic	14%
Glass	8%
Metal	5%
Misc.	40%

The table (left) shows the percentages of materials people in Switzerland throw in their trash. In the circle, make a circle graph to illustrate the data in the table. Label each part of the circle with the correct item.



PAYING THE POLLUTION PIPER

Environmental Studies Learning Concept

There are many types of environmental pollutants, some caused by nature and some by human endeavors. Those derived from nature are generally intermittent and dispersed, which lessens their impact upon the environment. Modern human-made pollutants are more consistently generated and concentrated throughout the environment. They result from a consumer-industrial society that generates technological processes, chemicals and materials, and consumer products that have the potential to harm the environment. Pollution can be reduced in a number of ways, including resource reduction and substitution, technological controls and consumer purchasing habits.

Natural systems have a limited capacity to cycle or disperse pollutants depending upon the type and concentration of pollutants. Each pollutant has its own pathway and effects once it enters the environment. Pollutants can move through air, water and soil, and they can change the balance of biogeochemical cycles. They can move up the food chain to become more and more concentrated in animals and humans, and can adversely affect human health in various ways.

Waste materials and substances, if improperly disposed, can be released into the environment where they follow various pathways with various effects. Recycling can reduce pollution when it reduces the need to extract resources from the Earth and reduces the material and energy requirements in manufacturing processes.

Vocabulary

contaminate – to make something impure or unfit for use by contact or mixture with something else

emission – substance discharged into the air, waterways or on land

fossil fuels – a natural resource ultimately derived from living things (coal, oil and natural gas) and converted into energy

hazardous – harmful to living organisms; possesses one or more of the following traits: toxic, corrosive, combustible, poisonous, carcinogenic

illegal dumping – disposing of solid waste on public or private property that is not designated as a licensed waste disposal facility

lifecycle analysis – a method of accounting for all the environmental impacts from a single product

litter – human-generated solid waste that is put in the wrong place or allowed to escape from a container

manufacturing – the process of turning raw material into finished products, usually with the aid of machines

methane gas – a colorless, odorless, flammable, gaseous hydrocarbon that is a product of decomposition of organic matter

non-point source pollution – undefined wastewater discharges, such as runoff from urban, agricultural or strip-mined areas; does not originate from a specific point

particulate – a type of air pollutant made of tiny solids suspended in the atmosphere

pathway – the route by which a pollutant travels throughout the environment from an original source

pollution – the contamination of soil, water or air by the discharge or improper disposal of matter, sounds or odors that have a negative effect upon the environment and human health

recycle – to collect and process waste materials for use in manufacturing new products

resource extraction – the process of taking a resource from the Earth and/or removing or separating it from a particular source

sewage – water that carries organic waste from humans and industry

solid waste – all garbage, refuse and sludge products from agriculture, forestry, industry, mining and municipalities

technology – a method, process or technique that uses machines to provide society with desired or needed consumer goods

Overview – PAYING THE POLLUTION PIPER



Activity 1: The Costly “Thing”

Description

Students *compare* using natural resources with using secondary or recycled materials to make aluminum cans. They *cooperate* in groups and *make inferences* about pollution values at various stages of production. Students *manipulate materials* to model quantities of pollution at various stages of manufacturing and *deduce* the environmental impact of recycling.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #11 – Name the resources needed to produce various goods and services, classify each resource by the factors of production, or suggest alternative uses for those factors.

Grade 4, Science #5 – Analyze a series of events and/or simple daily or seasonal cycles and predict the next likely occurrence in the sequence.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Science #4 – Identify the positive and/or negative impacts of technology on human activity.

Grade 6, Science #17 – Analyze the impacts of human activity on the ecosystems of the Earth.

Summary

This lesson includes two activities. They may be conducted independently; however, if both are used, teachers should decide which activity provides a better introduction for their students.

Activity 2: Pollution on the Move

Description

Students are introduced to the general concept of pollution, its causes and how it can affect the environment. Students *cooperate* in groups to *identify* causes of pollution by *making inferences* from clues supplied on a handout. They *observe* a community illustration of potential sources of pollution to *infer* pathways for pollution. Based on group discussion, students generate their own definition for the word pollution, and *hypothesize* the effects of different types of pollution on the environment.

Ohio Proficiency Test Learning Outcomes

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Science #4 – Identify the positive and/or negative impacts of technology on human activity.

Grade 6, Science #17 – Analyze the impacts of human activity on the ecosystems of the Earth.

2

Background Information

Pollution is something that **contaminates** the environment, affecting air, water and land. Contamination can be of varying degrees, from litter that creates a visual blight to **hazardous** substances that reach drinking water sources and threaten human health. Contaminates, in the form of pollutants, include waste materials, litter, noise, heat, gas, radiation and **particulate** matter. Nature, as well as humans, can be the cause of pollution. However, the intermittent and dispersed nature of natural pollutants generally weakens their impact on the environment.

Natural pollutants include particulate matter and gases from volcanoes, wastes and gases from living and dying plant matter, and particulate matter from dust storms and burning forests. Human-generated pollutants include litter and material dumped illegally, sewage, automobile emissions and fluids, and various land, water and air pollutants from extraction industries (mining, drilling and harvesting), manufacturing industries and power plants. Natural and human-generated pollutants enter the environment from various sources and spread throughout the environment in **pathways** that are influenced by soil porosity, slope of terrain, waterways, and wind and air currents.

Some pollution has a well-defined source, such as power plant smokestacks that release **emissions** into the air, or factory drain pipes that release waste matter into rivers or lakes. Other sources of pollution, referred to as **non-point source pollution**, are broader in scope and may originate

from many sources. These include rainwater runoff from parking lots, lawns, driveways, fields and mining areas that can deposit potentially harmful substances into soil and waterways, or cause soil erosion. Both point and non-point source pollutants can be hazardous to living organisms depending upon their chemical makeup and/or particle size.

Some human activities reduce pollution and its negative impacts on the environment. Hazardous materials reduction practices and pollution control **technology** can be applied by industry to reduce pollution. Farmers can reduce the use of pesticides and fertilizers, and practice tilling methods that prevent runoff into waterways. People can avoid littering and reduce the amount of household hazardous materials and lawn chemicals they use. **Recycling** is an effective pollution reduction method involving people and industry.

Recycling reduces pollution at the early stages of a product's lifecycle. First, it decreases the need to extract and process natural resources.

Resource extraction and processing can pollute air, land and water with hazardous materials. These processes require a great deal of energy. Burning **fossil fuels** (coal, oil, natural gas) releases pollutants (sulfur dioxide, nitrogen oxide and carbon monoxide) into the air. Second, the use of recycled materials can reduce the amount

of energy (and air pollution) required to manufacture products or consumer goods. Finally, using recycled materials also generates less **solid waste** to be landfilled or incinerated.

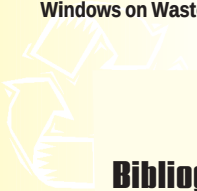
The U.S. EPA provides the following summation of specific pollutants reduced by recycling:

*A recent analysis of several studies concluded that the environmental impacts of recycled-content products are less than those of virgin products when the two are compared over their entire lifecycles. The analysis found that when compared to a system based on the use of virgin materials and landfilling or incineration, recycling and manufacturing products from recovered materials results in a net reduction in 10 major categories of air pollutants (aldehydes, ammonia, carbon dioxide, carbon monoxide, hydrocarbons, methane, nitrogen oxides, other organics, particulates and sulfur oxides) and eight major categories of water quality indicators and water pollutants (biochemical oxygen demand, chemical oxygen demand, dissolved solids, iron, metal ions, oil, sulfuric acid and suspended solids).**

It is important to note that the ability of recycling to accomplish reductions in pollution is variable, depending upon the material and manufacturing processes utilized. Each material and product has a unique lifecycle that must be analyzed in the context of specific conditions.

Recycling reduces pollution at the early stages of a product's lifecycle.

*R. A. Denison, "Environmental life-cycle comparisons of recycling, landfilling, and incineration: A review of recent studies," *Annu. Rev. Energy Environ.* 21:191-237; as cited in *Puzzled About Recycling's Value? Look Beyond the Bin*, U.S. Environmental Protection Agency, EPA530-K-97-008 (January 1998), p. 7.



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EarthSearch, by John Cassidy, Palo Alto, California: Klutz Press, 1994.

Facts on Domestic Waste and Industrial Pollutants, by Hugh Johnstone, New York: Aladdin Books Ltd, 1990.

How Cities Work, unknown, California: Ziff-Davis Press, 1995.

Media

Think Earth and “e” (video). A series of two videos for grades K-3 and 4-6. May be obtained by contacting the Educational Development Specialists, 5505 East Carson Street, Suite 250, Lakewood, CA 90713.

Educator Information

The ABCs of Environmental Education, Can Manufacturers Institute, 1997, 1625 Massachusetts Avenue, NW, Washington, DC 20036, (202) 232-4677.

A Breath of Fresh Air, Akron, Ohio: Akron Health Department, 1991.

Cartons, Cans and Orange Peels, Where Does Your Garbage Go?, by Joanna Foster, Clarion Books, 1991.

Common Questions about Health Effects, Citizens Clearinghouse for Hazardous Wastes, 1992.

Earth Science: 100 Reproducible Activities, Grand Rapids, Michigan: Instructional Fair, Inc., 1991.

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PAYING THE POLLUTION PIPER

Activity 1

The "Costly" Thing

Objectives

Students will be able to: (a) identify sources of pollution in the manufacturing process of aluminum cans; (b) explain how recycling processes reduce pollution and conserve natural resources; (c) sequence production stages in manufacturing processes; and (d) make inferences about the effect of recycling upon ecosystems.

Inquiries

- What types of pollution and waste are generated by industry in the production of consumer goods?
- How do industrial processes affect the environment?
- How can recycling reduce pollution?

Content Domain

Science – General science, earth science

Social Studies – Economics

Learning Outcomes

Citizenship, Grade 4, #11

Science, Grade 4, #5, #14 and Grade 6, #4, #17

Duration

50-75 minutes

continued next page

Preparation

Prior to conducting the activity, label each of the six containers with six sheets of paper as follows:

- Manufacturing & Air Pollution
- Manufacturing & Water Pollution
- Manufacturing & Land Pollution
- Recycling & Air Pollution
- Recycling & Water Pollution
- Recycling & Land Pollution

Place all Manufacturing Pollution signs on one table or location of the room, and place all Recycling Pollution signs at another table. Place one container on each sign, with water containers placed on each of the Water Pollution signs.

Procedure

1 Discuss the terms *manufacturing* and *recycling* with students. Tell students they will be working in pairs to determine how much pollution is generated in the manufacturing of aluminum cans, and compare that to how much pollution is generated during the recycling process. Review the back-

ground information and explain the various types of pollution to students in a manner they will understand. (Note: You may find that using Activity 2 first provides a better way of introducing students to pollution.) Explain that any part of the manufacturing process may or may not affect land, air and water quality or a combination of all three. The same will be true for recycling.

2 Have students work in cooperative groups. Distribute the two-page handout, *The Thing from Nature*, to each student. Have students complete the handout based on group discussion and consensus. They should compute and record total numbers of pollution points for each column and total all columns to indicate total pollution units for manufacturing with natural resources.

3 Distribute marbles, food coloring and cotton balls to each group. These items will represent the following:

- cotton balls = air pollution
- food coloring = water pollution
- marbles or building blocks = land pollution

As you review each group's answers on the handout, have a representative from the group deposit the number of items that their group assigned to air, land and water pollution in the *manufacturing* containers. (For example, if one group has a water pollution value of "3" for any part of the chart, they will add three drops of red food coloring to the appropriate water pollution container). Chart answers on the chalkboard.

- 4 Repeat steps 2 and 3, only this time use the handout, *The Thing Returns*, and deposit pollution units in the recycling containers.
- 5 Have students compare the differences between manufacturing with natural resources and manufacturing with recycled materials. Which of the two processes generates more pollution? Which of the two processes uses the most energy? Most water? Most resources? Why?
- 6 Using two stalks of celery or white carnations, place several cuttings in each container of red food coloring. Using a third container, add clear tap water and a stalk. After an hour, have students record their observations and discuss how pollution can affect living organisms.
- 7 Ask students why aluminum cans are made and what purpose they serve. Have them describe the technologies required to make aluminum cans and how these technologies affect the environment. Discuss the technological aspects of recycling and how these affect the environment.

Assessment

Method A: Have each student draw and label the sequential stages in the making of an aluminum can from a natural

resource and another sequence for making a can from recycled cans.

Method B: Complete the multiple-choice handout, *Questionable Things*.

ANSWERS: 1. c, 2. b, 3. b, 4. c

Extensions

- 1 Have students search the Internet for more information about local recycling programs. For information specifically about aluminum cans, use the following addresses:

Aluminum Association -
www.aluminum.org

Can Manufacturers Institute -
www.cancentral.com

- 2 Have students create two recycling wheels. One wheel should depict a natural cycle of their choice (leaves of a tree, water cycle, seasons, etc.), the other wheel should depict the recycling of a material. Have them identify how each are similar and how each differ. Have students identify how the cycle is continuous for each. List the things needed to continue each cycle.

- 3 Discuss with students other recyclable products, such as glass bottles, steel cans, newspaper and plastic bottles. Have them research these items and generate comparative sequential stages for pollution, like what was done with aluminum cans in the activity.

PAYING THE POLLUTION PIPER

Materials

Six large, clear containers (two containers filled half-way with water); **six sheets of notebook or construction paper**; **couple bags of cotton balls**; **several bottles of red food coloring** (one per student group or assign one person per water container to dispense red food coloring during the activity); **several bags of marbles** or **colored building blocks**

Handouts

- [The Thing from Nature](#)
- [The Thing Returns](#)
- [Questionable Things](#)

Student Handout



THE THING FROM NATURE

(Manufacturing Aluminum Cans from Natural Resources)

Directions: Complete the chart below. Guess how much pollution enters the environment during each process by assigning pollution points for land, air and water. Pollution points are based on your group's discussion. Assign 8, 9 or 10 points if you think the pollution highly impacts the environment; 4, 5, 6 or 7 points if you think the pollution moderately impacts the environment; and 1, 2 or 3 points if you think the pollution has a low impact on the environment. Use your best judgment to determine points for each column.

Note: Some processes may affect only one part of the environment—land, air or water. Other processes may affect more than one part.

PROCESSES

POLLUTION POINTS

	Land	Air	Water
1. Aluminum is made from the mineral bauxite, which is found deep in the Earth's crust. Bauxite is often mined in other countries, using big machines that strip aside plants and soil.			
2. The bauxite ore is shipped to the United States in trucks, ships and railroad cars to processing plants.			
3. Large electric currents are used at the processing plant to separate the oxygen from the aluminum. The rest of the ore is thrown away.			
4. The aluminum is heated at very high temperatures and poured into large blocks or ingots. Water is used to help cool the aluminum. The water, which may be very hot, enters streams or lakes.			
5. The aluminum ingots are transported to another processing plant in trucks or railroad cars.			
6. Aluminum ingots are coiled into long sheets of aluminum by machine. These coiled sheets will be used to make beverage cans.			
7. Aluminum sheets are coated with a protective chemical. Some chemicals spill on the floor, which is cleaned with soap and water.			
8. The aluminum goes through a large, electric cutting machine that will shape the can. Scraps may fall on the floor. The scraps will be thrown away or recycled.			

Student Handout

THE THING FROM NATURE, CONTINUED

PROCESSES	POLLUTION POINTS		
	Land	Air	Water
9. Aluminum cans are shipped to a printing plant in trucks or railroad cars.			
10. Cans are printed with ink and transported in trucks or railroad cars to a beverage plant.			
11. Cans are filled and shipped to stores by trucks or railroad cars.			
12. Consumers buy products in aluminum cans. They use the product and throw away the cans. A truck takes the garbage to a landfill where it is covered with dirt.			
TOTAL POINTS			

Student Handout



THE THING RETURNS

(Manufacturing Aluminum Cans Using Old Aluminum Cans)

Directions: Complete the chart below. Guess how much pollution enters the environment during each process by assigning pollution points for land, air or water. Pollution points are based on your group's discussion. Assign 8, 9 or 10 points if you think the pollution highly impacts the environment; 4, 5, 6 or 7 points if you think the pollution moderately impacts the environment; and 1, 2 or 3 points if you think the pollution has a low impact on the environment. Use your best judgment to determine points for each column affected.

Note: Some processes may affect only one part of the environment—land, air or water. Other processes may affect more than one part.

RECYCLING PROCESSES

POLLUTION POINTS

	Land	Air	Water
1. Aluminum cans are collected by a truck and taken to a recycling plant where they are baled by machine.			
2. Aluminum is shipped in trucks or railroad cars to an aluminum processing plant.			
3. Baled aluminum is melted using about 95 percent less energy than it takes to melt bauxite ore. The melted aluminum is poured back into ingots. Water is used to cool the aluminum.			
4. The aluminum ingots are transported to another processing plant in trucks or railroad cars.			
5. Aluminum ingots are coiled into long sheets of aluminum by machine. These coiled sheets will be used to make beverage cans.			
6. Aluminum sheets are coated with a protective chemical. Some chemicals spill on the floor, which is cleaned with soap and water.			
7. The aluminum goes through a large, electric cutting machine that will shape the can. Scraps may fall on the floor. The scraps will be thrown away or recycled.			
8. Aluminum cans are shipped to a printing plant in trucks or railroad cars.			
9. Cans are printed with ink and transported in trucks or railroad cars to a beverage plant.			
10. Cans are filled and shipped to stores in trucks or railroad cars.			
11. Consumers buy products in recycled aluminum cans. They use the product and recycle the cans.			
TOTAL POINTS			

Student Handout

QUESTIONABLE THINGS

Directions: Provide the one best answer in the space beside each question.

- ____ 1. When aluminum cans are recycled, which process below is not needed to make a new can?
- a. aluminum ingots are transported
 - b. coating aluminum sheets with a protective chemical
 - c. mining bauxite ore
 - d. aluminum sheets are cut into cans
- ____ 2. Studies show that recycling reduces the amount of energy needed to manufacture a product. Energy saved by recycling reduces emissions of sulfur dioxide, nitrogen oxide and carbon monoxide into ____.
- a. waterways
 - b. air
 - c. land
- ____ 3. Fossil fuels, such as coal and natural gas, are burned to generate lots of energy to make new aluminum cans. Recycling old aluminum cans to make new aluminum saves energy. By saving energy, we burn less fuel and reduce the amount of ____.
- a. labor
 - b. pollution
 - c. needs
 - d. wants
- ____ 4. Recycling saves energy, saves natural resources and ____.
- a. increases pollution
 - b. wastes people's time
 - c. saves land space for disposal
 - d. reduces consumption



PAYING THE POLLUTION PIPER

Activity 2

Pollution on the Move

Inquiries

- What is pollution and how can pollutants be classified?
- How do pollutants enter and move throughout the environment?
- What are the potential effects of pollution?

Content Domain

Science – General science, earth science, biology

Social Studies – Geography

Learning Outcomes

Science, Grade 4, #14 and Grade 6, #4, #17

Duration

60 minutes

Materials

One envelope (for each student), **notebook paper**, **crayons**

Handouts

- [Mapping Pollution](#)
- [Pollution Clues](#)
- [Venn Diagram](#)

Objectives

Students will be able to: (a) describe pollution; (b) identify sources of natural and human-made pollutants; (c) explain how pollutants enter and move throughout the environment; and (d) explain how recycling reduces pollution.

Preparation

Explain to students that they will be studying pollution. As a pre-assessment activity, have each student write his/her own definition of the word pollution without any discussion. Students should fold their responses and seal them in envelopes and write their names on the envelopes. Collect all envelopes for later use.

Procedure

1 Divide students into groups, and distribute the handout, *Mapping Pollution*, to each student. Explain that the illustration depicts how pollution is generated by humans and by nature. Have students identify sources of natural pollution and sources of human-made pollution. Collect all the envelopes for later use.

2 Discuss the term *pathway*. Explain that there are three basic pathways: air, land and water. Identify one source of pollution on the map and a specific pollutant from that source and discuss potential pathways for that pollutant.

3 Distribute the handout, *Pollution Clues*, to each student in each group. Working in groups, have students complete the handout, referring to the illustration, *Mapping Pollution*, if needed. If students have difficulty making inferences to complete the handout, *Pollution Clues*, you may wish to write the answers (out of order) on the board and have students choose the answers that match the clues.

ANSWERS for handout, *Pollution Clues*:

1. leaves
2. methane gas
3. non-point source pollution
4. people who litter
5. fuel for energy
6. fire
7. mining
8. illegal dumping

4 Review group answers and discuss. Have students identify each source of pollution on the handout, *Mapping Pollution*, which is described on the handout, *Pollution Clues*. They might trace with a different colored marker or crayon each of the different pathways for each source of pollution.

NOTE: When the word “contamina-



tion” appears in the clues, discuss with students how contamination may represent hazardous materials, some harmful to human health. You may wish to discuss how some hazardous materials accumulate in food chains (algae to fish to larger fish) until they reach humans who then ingest those chemicals, which may cause serious diseases or other disorders.

5 Discuss ways that pollution can be prevented in each of the examples.

6 Have students identify the recycling center in the illustration, *Mapping Pollution*. Have them identify three pollutants (sources of pollution) that are reduced when recycled materials are used to make products.

ANSWERS to teacher inquiry:

- potential water, land and air pollutants are reduced by recycling because there is less need for mining
- air (energy) pollution and potential water pollution from the *factory* are reduced by recycling
- land, air and potential water pollutants from the *landfill* are reduced by recycling

If you did not conduct Activity 1, *The “Costly” Thing*, review the background information and explain the recycling concepts (how recycling reduces pollution) to students.

Assessment

1 Have each student write a new definition for pollution. Return envelopes made by students at the beginning of the activity. Have them compare their original definition of pollution to their new definition.

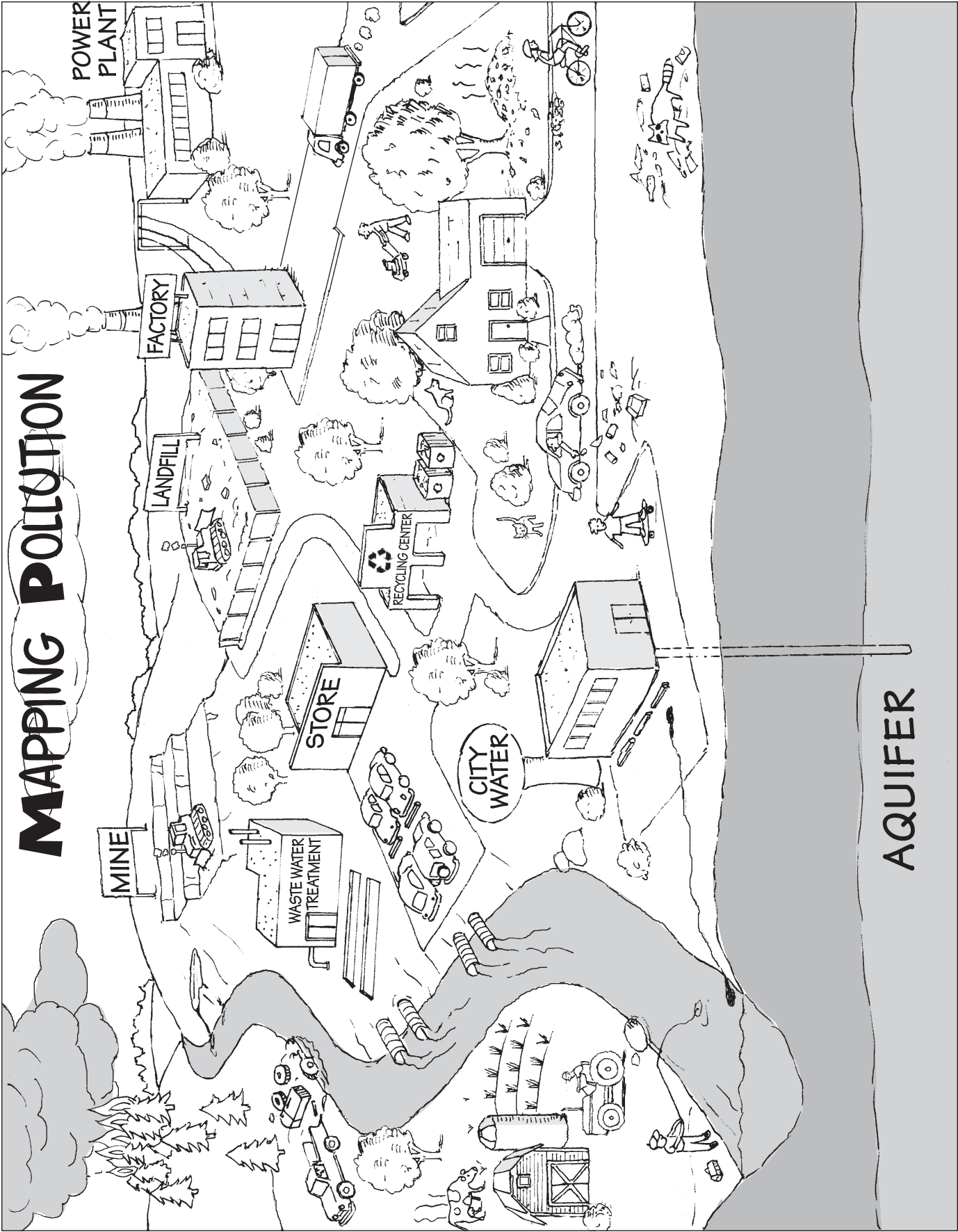
2 Have students add a source of pollution (not already provided) to the illustration on the handout, *Mapping Pollution*, and trace a pathway for it.

3 Using the handout, *Venn Diagram*, have students compare and contrast the difference between natural pollutants and human-generated pollutants.

Extension

Have students identify pollution reduction strategies they can employ at home and at school. Create a pollution action bulletin board. Have students identify ways to measure their impact.

Student Handout



Student Handout

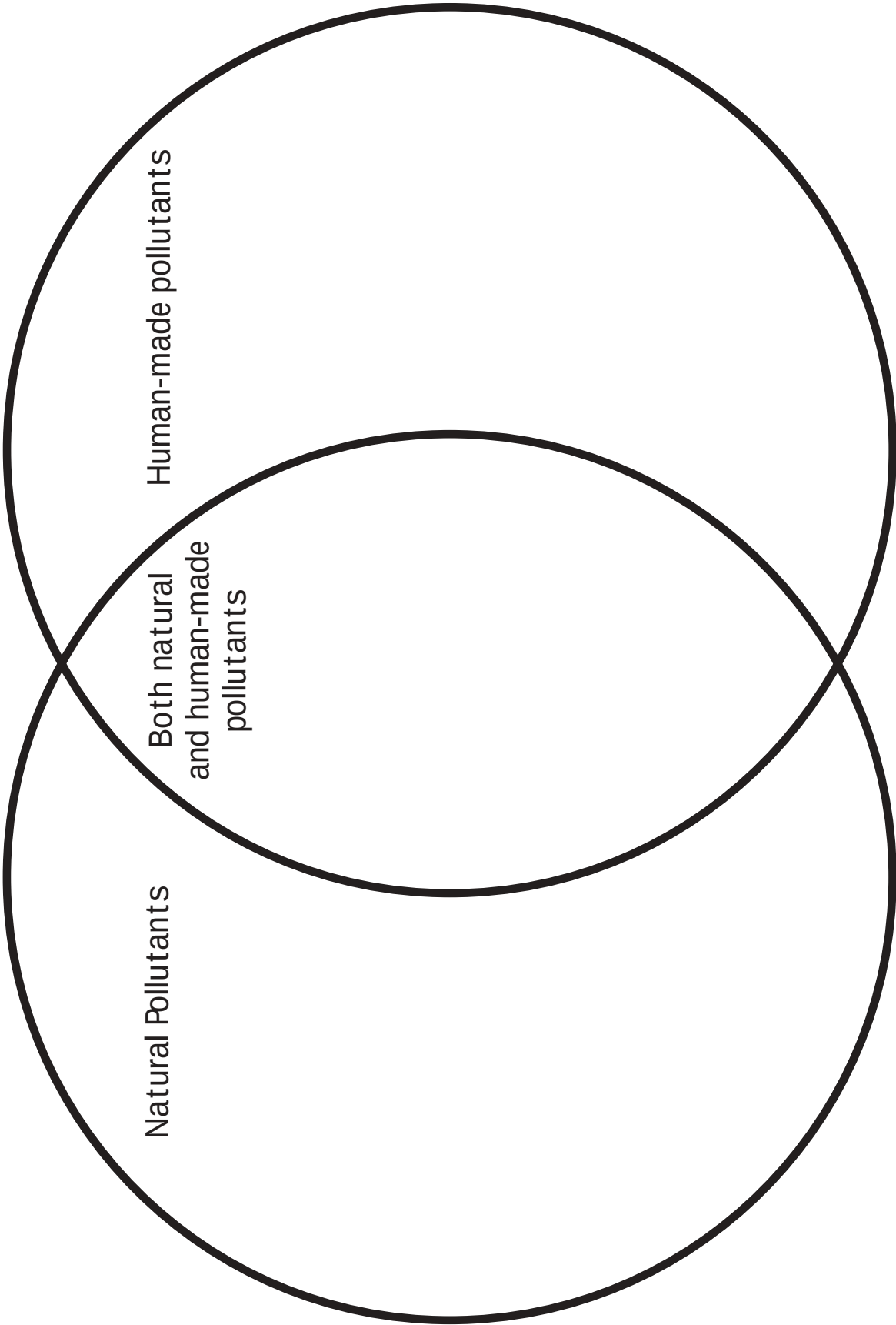


POLLUTION CLUES

Directions: Complete the pollution chart below by writing answers in the first column for each example of pollution. The clues in the squares to the right should help you pick the “cause.”

CAUSE	SOURCE	PATHWAY	EFFECT
1.	trees, branches of trees	land, air (wind) and waterways (rivers, lakes, storm sewers)	may collect on land and beside buildings, suffocate grass, supply nutrients to soil
2.	cows, termites, landfills (anaerobic bacteria)	air and atmosphere	can combust creating explosions and fire, may contribute to global climate change
3.	rainwater on driveways, parking lots, lawns, fields	land (yards, streets), waterways (sewers, creeks, rivers, lakes)	may contaminate drinking water and water habitats for plants and animals
4.	people everywhere	air (wind), waterways, land	collects on land, may attract mice, rats, and makes the Earth look ugly
5.	factories, automobiles, power plants, homes	air and atmosphere	may contaminate the air and contribute to global climate change
6.	heat and combustion, volcanoes, lightning	air (wind), land (forests, buildings)	may release particulate matter (and sometimes harmful gases) into the air; may destroy forest land and buildings
7.	digging minerals (iron ore, copper, bauxite) out of the land and drilling for fossil fuels (coal, oil, natural gas)	land, waterways (rivers, lakes)	may cause soil erosion, may contaminate water and soil
8.	waste material (some may be hazardous) dumped anywhere in quantity	land, waterways (rivers, lakes, ground water)	may contaminate soil, waterways and attract mice, rats and other vermin

VENN DIAGRAM





HOME, SAFE HOME

Environmental Studies Learning Concept

The increase in the production of hazardous materials and emissions in the past century has resulted from technological and scientific advances that led to the development of numerous consumer products, which have made life easier, safer and more comfortable. Yet, there have been environmental consequences of this progress, including pollution and health risks from production processes and chemicals related to many consumer products.

Household hazardous materials serve valuable, functional purposes, such as home cleaning and protection from pests. However, household hazardous materials may have harmful effects when misused by humans and disposed of improperly. Sometimes, alternative (less hazardous) materials can be substituted for the original hazardous materials.

Vocabulary

corrosive chemical – a chemical or its vapor that can destroy a material or living tissue; capable of wearing away by chemical action

explosive chemical – a chemical that can cause sudden, instantaneous release of heat and pressure

flammable – catches fire easily and tends to burn rapidly

hazardous material – a material that is toxic, corrosive, reactive and/or explosive

ignitable chemical – can cause sudden, instantaneous release of heat and pressure; flammable

ingestion – to take in by swallowing

inhalation – to take in by breathing

irritant – causes soreness or swelling of skin, eyes, mucus membranes or respiratory system

irritation – irritability, soreness, roughness or inflammation of a bodily part

landfill – a site for the burial and decomposition of solid waste

poison – a substance that through chemical action kills or injures an organism

reactive chemical – a chemical that can spontaneously react with air and water, generate toxic gases and become unstable when exposed to heat or shock

toxic – can cause injury or death if swallowed, inhaled or absorbed through the skin; poisonous

Overview - HOME, SAFE HOME



Activity 1: Home, Safe Home

Description

Students define and discuss the elements of household hazardous waste. They *make inferences* from this information to identify potential consequences to human health and the environment from the misuse and improper disposal of household hazardous materials. They *identify* products and locations of hazardous materials in their households. Students *read* text to *identify* alternatives to hazardous materials and *manipulate materials* to make a “green cleaning wheel” that is a quick reference for alternative products.

Ohio Proficiency Test Learning Outcomes

Grade 4, Reading #13 – Demonstrate an understanding of text by retelling the information, in writing, in own words.

Grade 4, Reading #14 – Identify and interpret vocabulary critical to the meaning of the text.

Grade 4, Reading #17 – Infer from the text.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Reading #12 – Infer from the text.

Grade 6, Science #16 – Analyze behaviors and/or activities that positively or negatively influence human health.

Summary

This lesson consists of a single activity divided into three parts. The first part provides information about hazardous materials and the concepts needed to conduct the other two parts of the activity.

Background Information

When people think of hazardous waste, they generally think of the waste produced by industry. But many of the products in our homes contain **hazardous** substances. Once used, the product is thrown out along with other household wastes, and residual amounts of hazardous substances often remain in the container. These hazardous materials then go to a disposal facility, such as a **landfill** or an incinerator. Sometimes, however, people dispose of household hazardous wastes on their own by burning them, dumping them on the ground or into waterways, or by pouring them down a sink, toilet or storm sewer system. These actions have the potential to

threaten human health and the environment.

In most cities and towns, if a hazardous substance is poured down a sink or flushed down a toilet, it will flow through the sewer system to a sewage plant. There, some hazardous chemical wastes may be removed or treated to make them less harmful. However, for various reasons, **toxic** substances are not always removed or properly treated, and these substances can be discharged or absorbed into connecting waterways (creek, stream, river or lake). Sometimes in a sewage treatment plant, hazardous wastes kill the living organisms that should be feeding on the harmful bacteria in organic waste.

If the waste from a home flows

into a septic tank, it will eventually spread out through a drain field with the potential to reach groundwater or waterways. If hazardous substances are dumped on the ground, they can travel to a storm drain, waterway or down into the groundwater. Groundwater can become contaminated when the ground becomes saturated by rainwater.

The act of improperly disposing of household hazardous wastes is similar to illegally dumping industrial hazardous wastes. It is important to properly dispose of household products that contain hazardous substances because they can potentially threaten human health and the environment.

Background Information, continued

Bibliography and Additional Resources

Educator Information

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Internet

Life on the Planet:
www.cleanhouse.com

HOME, SAFE HOME

Inquiries

- What is a household hazardous product?
- How do we come in contact with these products?
- Are there alternatives to these materials?
- Why should we be concerned about throwing household hazardous products in our garbage?

Content Domain

Language Arts – Reading
Science – General science, health

Learning Outcomes

Reading, Grade 4, #13, #14, #17 and Grade 6, #12

Science, Grade 4, #14 and Grade 6, #16

continued next page

Activity 1

Objectives

Students will be able to: (a) identify potential household hazardous products; (b) describe the potential effect of hazardous products on human life and the environment; and (c) identify less hazardous alternative products.

Procedure

PART A

1 Discuss with the class what makes a product a hazardous material. Show students examples of potentially hazardous products that include the following traits:

toxic chemical – harms or kills plants and/or animals by poisoning; can be poisonous to humans

corrosive chemical – causes visible destruction of, or irreversible changes in

living tissue; requires appropriate container to avoid leakage from corrosion

reactive chemical – can spontaneously react with air or water to cause an explosion; may generate toxic gases and become unstable when exposed to heat or shock

ignitable chemical – can cause sudden, instantaneous release of heat and pressure; poses a fire hazard, is flammable; can burn or catch on fire

Before writing these traits on the board, read the labels of the hazardous products used as examples and have students

make inferences about how the products may be potentially harmful.

Have students write down the four traits of hazardous materials, using their own definitions, based on class discussion of the terms. They will need these definitions for a homework assignment in Part B.

2 Discuss how hazardous products become waste with the potential to harm the environment. (They can be thrown in household trash with contents and residues in the containers and landfilled; contents are sometimes poured down a storm sewer, dumped on the ground, poured down the drain or toilet). Explore with students how hazardous materials, once in the environment, can move throughout the environment and have harmful effects by using the handout *Mapping Pollution*, p. X-14, in Lesson X, *Paying the Pollution Piper*.

3 To explore the potential effects of hazardous materials on people, use the handout, *Unsafe Situations*, for discussion points.

4 Discuss the nature of alternative products (potentially safer, use fewer chemical ingredients and may be less expensive). Give examples of some of these substitutes and their application.

Divide students into groups and give each student the handout, *Green Cleaning*. Give each group the handout, *Alternative Products*, to complete, using the information from the handout, *Green Cleaning*. Keep in mind that there may be more than one alternative or combination of alternatives.

PART B

1 Have students conduct a home inventory. You may give each student the layout of a generic house on the handout, *Caution! What's Where in My Home?*, or if time is available, have stu-

dents draw a “blueprint” of their home and label each room. Make sure they include the garage and basement (if these exist in their home), and the kitchen, bathroom and utility room.

2 Have students take their inventory sheet home. Moving from one room to another, have students identify one or two household products per room, as well as identify the purpose of each product. Based on reading the label, have students determine how it may be potentially hazardous. They may need the definition sheet produced in Part A, Step 1 to decide if the product is hazardous.

NOTE: It may be helpful and precautionary to send a letter home with the students indicating that parental help may be needed to identify and handle household hazardous products and to help interpret labels.

3 Discuss students’ inventories in class and make a list of all the products mentioned, giving the generic name for each, its purpose and any descriptions that indicate hazardous potential.

PART C

1 Have students create a “green cleaning wheel.” Prepare the wheel by reproducing the templates on card stock. See handouts, *Small Wheel* and *Large Wheel*. Cut out patterns.

2 Assemble the wheel by punching out the center holes and securing with a brass fastener.

3 The *Large Wheel* includes a sample answer. Have students use the handout, *Green Cleaning*, to research alternative products to complete their wheels.

HOME, SAFE HOME

Duration

Part A: 40 minutes

Part B: 20 minutes plus homework assignment

Part C: 30-40 minutes

Materials

1” brass fasteners, paper punch, card stock wheel templates, scissors, fine line markers, drawing paper, labels or copies of various household cleaners

Handouts

- *Unsafe Situations*
- *Green Cleaning*
- *Alternative Products*
- *Caution! What's Where in My Home?*
- *Small Wheel and Large Wheel*
- *Home, Safe Home*

Assessment

1 Administer multiple choice assessment handout, *Home, Safe Home*.

ANSWERS to *Home, Safe Home*:

1. d, 2. c, 3. b, 4. d, 5. c

2 In groups, have students make “green cleaning kits.” Have students identify what and why they included each item.

3 Have students design brochures that promote alternative products for the home and garden.

Extensions

1 Using alternative cleaning methods is sometimes considered “old fashioned.” Have students interview a grandparent or another elder and learn how the house was cleaned, pests were eliminated and other household chores were handled before current products were available.

2 Students can try using “green” cleaning for a week. Test some alternative cleaning recipes and compare results. For example, use baking soda to clean the sink instead of scouring powder. Try a carpet freshener made of cornstarch and cinnamon instead of a commercial product.

NOTE: Students should ask an adult for assistance. To show students how chemicals react, mix vinegar and baking soda. Discuss the properties and why it is potentially dangerous to mix household cleaners.

3 Examine specific alternative products. Research prices of commercial cleaners and alternative products. Have students compare the price information by creating a chart. Remember, measurements of weight should be consistent for accurate comparisons.

4 To provide a hands-on example of an alternative product, students can make bath salts. Combine 1 cup of Epsom salts with six drops of scented oil (rose, vanilla) and six drops of food coloring. Shake or stir until blended and pour into a decorative jar.

5 Sometimes the best way to clean is not to make a mess in the first place. Have students brainstorm a list of things to do to help avoid a mess, eliminating the need to use commercial cleaning products, and conserve resources and time. For example, use doormats inside and out; wipe down the shower after every use to decrease soap and shampoo buildup; and use towels more than once.

UNSAFE SITUATIONS

Allow students to predict and brainstorm possible consequences. Share information with students through discussion and use these scenarios as story starters.

PRODUCT	SITUATION	PREDICTION
Drain cleaner	When doorbell rang, the bottle was left on the bathroom floor. A baby was playing nearby.	Child could drink it; product is corrosive to skin and eyes.
Lemon furniture oil	When polishing some furniture, the cap was lost. Polish was then placed in a glass near the sink.	Someone might drink it, thinking it was safe; color and scent make it attractive.
Pills	Medicine was left on nightstand to help remind the patient to take it.	Children may assume it is candy and eat it.
Antifreeze	After changing the antifreeze in a car, someone threw it into a ditch in front of the house.	Pets have died from drinking puddles of antifreeze; they are attracted by its sweet taste; environmentally damaging.
Aerosol air fresheners/deodorizers	A cooking smell was unpleasant so air freshener was sprayed in the kitchen. The can was left sitting on the stove.	Fumes make residents sick, or adhere to food; the can could explode due to heat.
Chlorine bleach and ammonia	The bathroom tile wouldn't come clean using a bleach cleanser, so the person cleaning mixed some ammonia with the cleanser to make it stronger.	Mixing chlorine bleach and ammonia releases a toxic gas; the fumes can result in eye, throat and nose irritations and breathing difficulty; products should never be mixed.
Furniture stripper	Your neighbor decided to strip the paint off an old chair. He's working in his workshop, and turns on the fan.	Using a fan in closed quarters will only recirculate the bad air; such products need extreme caution and plenty of fresh air.
Hair spray	Your sister sprayed her hair to keep the style in place. She left the can on the radiator in the bathroom.	Fumes from chemical sprays can irritate and damage skin, eyes and lungs; they can also cause internal harm by entering the blood stream through the lungs; container can explode from heat.
Pesticides	To kill ants in the kitchen, an insect spray was applied to the floor. People in the home are often barefoot.	Chemicals can penetrate socks and be absorbed through the skin; health effects of pesticides, especially long-term effects, are not fully known.
Oven cleaner	Although the product called for the use of rubber gloves, the housekeeper felt they were too clumsy and used the product without them.	The chemicals could cause the skin to burn or develop a rash; skin and eye contact should be avoided.

* Prepared by Dr. Joseph Heimlich, OSU Cooperative Extension; adapted from *Oscar's Options: A Supplementary Environmental Education Curriculum*, by Carole O.Bell and Martha M. Schwartz (Rhode Island State Department of Education, Department of Environmental Management, 1986).

Student Handout

GREEN CLEANING

GREEN CLEANING

Hair spray removes ink. Spray stain, let stand and wash as usual.

Denture tablets clean vases. Fill vase about an inch from the top with water. Add tablets and let dissolve completely. Rinse well.

Crayons cover scratches. Rub appropriate color of crayon on scratch.

Toothpaste cleans gold. Rub gold jewelry with paste. Use brush if necessary. Rinse well.

Mayonnaise removes water spots. Spread mayonnaise on water spot. Let soak into wood. Wipe off thoroughly.

Walnuts cover scratches. Scratches on furniture can be covered by rubbing walnut or other nutmeat directly on them.

Soda water cleans carpet stains. Blot stain with soda water and sponge.

Aluminum foil removes tarnish. Fill a pan with water. Add 1 tbsp. each of salt and baking soda and a few sheets of aluminum foil. Add silver and let mixture set for an hour or so. Tarnish goes onto the foil. Rinse the silver in hot water and polish dry.

Lemon juice cleans silver. Soak silver in lemon juice. Rinse well with hot water and polish dry.

Shampoo removes laundry stains. Use shampoo to remove ring around the collar.

Ground spice with cornstarch removes carpet odor. Mix spice (cinnamon, cloves, etc.) and cornstarch, wait several hours or overnight and vacuum.

Vinegar cleans windows. Mix a small amount of vinegar with 1 cup water and spray as usual.

LEMONS



Place cut lemons and water in a tarnished pan or place tarnished utensils in a pan with lemon water. Stew on low, for about an hour or so, until stains are gone.

Place slices of lemon in a pot of water or potpourri warmer with water. Simmer gently in the open pot for an hour.

Rub cut lemons into a washed cutting board to eliminate food odors. Set slices of lemons around the kitchen while preparing food.

Pour baking soda into a drain and follow with $\frac{1}{2}$ cup of lemon juice. Let the mixture stand for 15 minutes (will foam) before rinsing with hot water.

Use lemon juice as a window cleaner.

Lemon juice may be used to clean brass and copper. Add some salt for tough cleaning jobs.

Lighten wood, such as butcher blocks, cutting boards and raw tabletops, by saturating a sponge with lemon juice and washing the wood. Do not rinse.

Bleach clothes by adding $\frac{1}{4}$ cup of lemon juice to the wash cycle. It can also be added to the rinse cycle.

Remove ink stains from cloth by soaking in lemon juice.

Remove mold or rust from cloth by using a paste made from salt and lemon juice.

Clean chrome with lemon juice or rub a lemon directly on the chrome.

Rinse hands with lemon juice to remove onion odors, berry stains, food coloring, etc.

Remove shampoo residue by rinsing hair with lemon juice and warm water.

GREEN CLEANING, CONTINUED

VINEGAR

Running vinegar through a coffee pot will clean it easily. Remember to run clear water through after the vinegar cycle.

Adding 1 cup of vinegar to the rinse cycle will brighten dark colors.

Vinegar and baking soda will keep the drain and toilet bowl clean. Pour 1 cup of baking soda followed by $\frac{1}{2}$ cup vinegar, wait, then rinse with hot water.

For a clean, spotless rinse for dishes, add 1 or 2 tbsp. of vinegar to dish water. It also helps to cut grease.

Clean brass and copper using vinegar and lemon juice or vinegar and salt, if an abrasive is needed.

Remove soap build-up from shower curtains by cleaning it with a sponge saturated in vinegar. This will also help kill mold and mildew.

Scrub the butcher block with vinegar. Rinse well.

Wash floors with 1 cup of vinegar added to a pail of water.

Carpet stains can be removed by mixing vinegar with water. Rub with sponge, then rinse well.

Add vinegar to the rinse water to help soften fabric and control static cling and lint.

Remove berry stains by soaking in vinegar.

A solution of half vinegar and half water, when applied with a piece of terry cloth, will remove fingerprints and other smears from appliances.

Clean and shine plant leaves of large house plants with a solution of $\frac{1}{4}$ cup white vinegar to 1 gallon cool water. Apply with a soft cotton cloth.

Pour vinegar on unwanted grass growing between cracks.



BAKING SODA

Freshen up by placing baking soda in an open container in small areas, such as the refrigerator, closets, etc.

Sprinkle baking soda on the carpet to help control odors. Wait several hours or overnight. Vacuum as usual.

Baking soda and scouring pads will clean an oven without the strong fumes of commercial cleaners.

Baking soda may be used as a scouring powder for sinks, counter tops, etc.

Control cat litter box odor by sprinkling baking soda in the box.

Create spray air freshener by combining 2 tsp. of baking soda and 2 tsp. lemon juice with 2 cups of hot water. Dissolve and use in a spray bottle.

Control garbage odors by adding a sprinkle of baking soda to the trash container every time you add garbage.

Clean and deodorize the microwave with a paste of baking soda and water. Wash and rinse. Then, to control odors, keep a box of baking soda inside between uses.

Baking soda and water makes a cleaning paste for stainless steel and helps rub away heel or skid marks.

Odors can be removed from clothes by soaking overnight in the rinse cycle with a box of dissolved baking soda.

Use baking soda to clean baby's things, such as toys, high chair, changing table, etc. Apply to damp sponge, wipe and rinse.

Use baking soda and water to wash off vinyl furniture and car seats.

Baking soda should be kept handy near the grill or stove; it will quickly extinguish flare-ups or sparks.

Keep a box of baking soda in the cooler between uses to help eliminate odors; especially helps during the winter "down" time.

Student Handout

ALTERNATIVE PRODUCTS

Directions: Many of the products we use in our homes are potentially hazardous. Often, safer, less expensive alternatives produce similar results. For each of the products below, list an alternative method. Remember, there may be more than one answer.

1. room freshener _____
2. carpet scent _____
3. drain opener _____
4. toilet bowl cleaner _____
5. shower curtain cleaner _____
6. window cleaner _____
7. floor cleaner _____
8. microwave cleaner _____
9. brass polisher _____
10. cover scratches _____
11. coffee pot cleaner _____
12. laundry stains _____
13. finger print remover _____
14. degreaser _____
15. stainless steel cleaner _____

Student Handout

CAUTION! WHAT'S WHERE IN MY HOME?

BATHROOM

KITCHEN

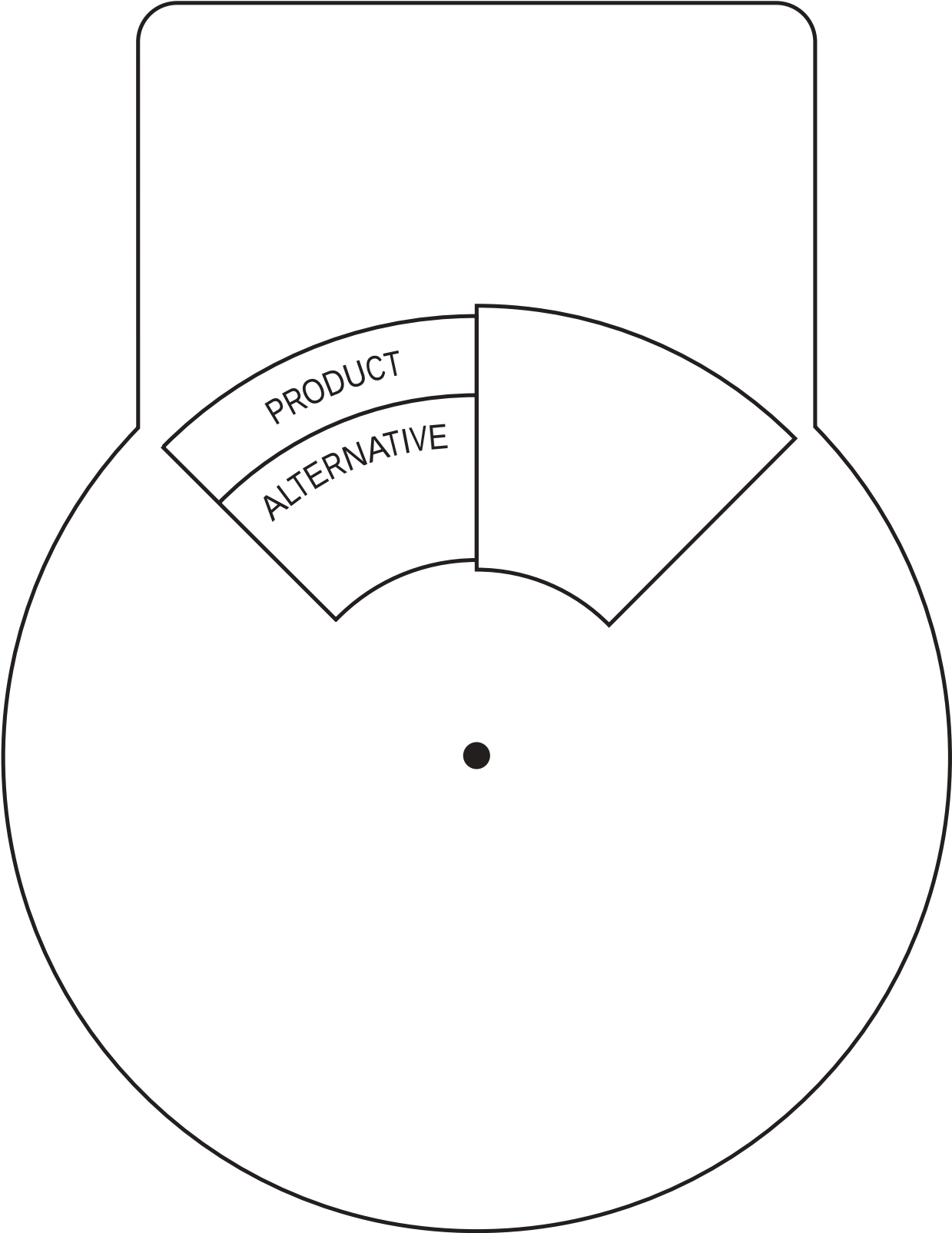
UTILITY ROOM

GARAGE

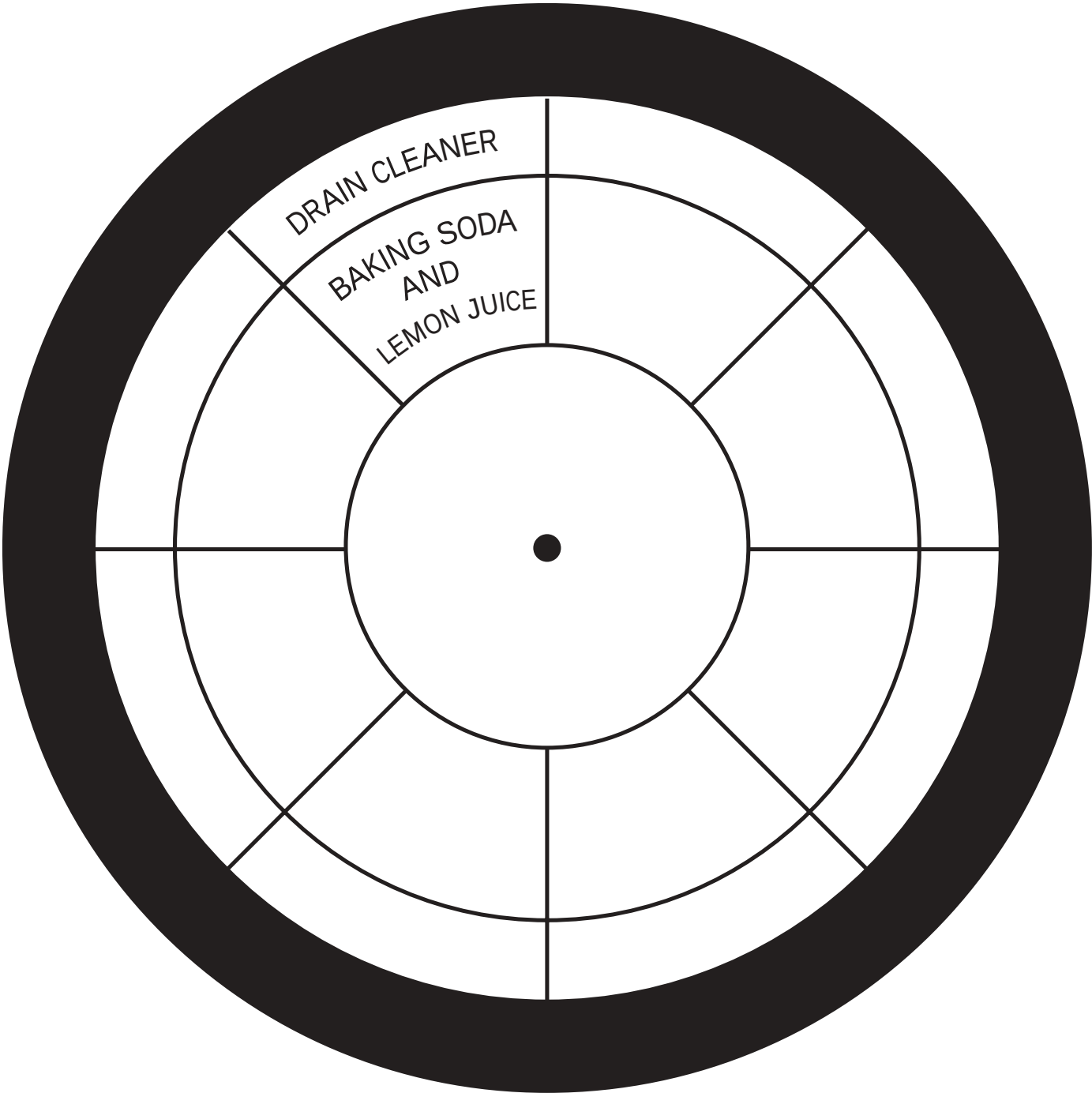
BASEMENT

OTHER ROOM:

SMALL WHEEL



LARGE WHEEL



Student Handout

HOME, SAFE HOME

Directions: Circle the letter of the best answer for each of the following.



- 1** Which of the following are types of hazardous material?
 - a. material that has a label on it
 - b. material that is liquid, dark and thick
 - c. material that is poured down a sink drain
 - d. material that is toxic, ignitable, corrosive
- 2** Vinegar, baking soda and lemon juice are examples of...
 - a. items on a grocery list
 - b. items which should not be put into a landfill
 - c. alternative cleaning products
 - d. items needed to bake a cake
- 3** If something is toxic it means...
 - a. it is old or outdated
 - b. it is poisonous and harmful
 - c. it is very explosive
 - d. it is difficult to find
- 4** Alternative cleaning products are...
 - a. "the way our grandparents might have cleaned"
 - b. usually less expensive than traditional cleaning products
 - c. usually safer than traditional cleaning products
 - d. all of the above
- 5** If hazardous material is poured down a sink drain or left in the garbage...
 - a. it will not affect anyone who does not go near the drain or the garbage
 - b. it will evaporate into the air and cause no harm
 - c. it will end up in the environment where it may cause harm to living things
 - d. it will be absorbed by the pipes in the sewer system



THE TROUBLE WITH LITTER

Environmental Studies Learning Concept

Many sources of pollutants are irritating to aesthetic sensibilities. These include litter (visual pollution), noise (sound pollution) and odors (olfactory pollution). There are also natural irritants, such as storm noises, skunk odors, and plant and animal litter in the form of shells and rinds left by animals, animal dung and dead plants and animals. Artificial, human-generated irritants include noises from machines, odors from household and industrial solid waste, and misplaced solid waste in the form of litter. Sometimes irritants can threaten the health of living organisms, such as ingested litter that causes animals to suffocate or a noise level that causes hearing loss.

Litter is a special concern in local communities. It has various sources associated with human activity that generate visual and olfactory pollution. Some forms of litter, such as waste tires and decomposing food, can be health hazards depending upon the location. Governments can establish laws and policies to reduce irritating pollutants.

Vocabulary

(Note-**sources** refer to sources or causes of litter)

commercial source – the waste generated by stores and businesses

construction source – scrap building materials that blow away from the construction site

hazard – something that may be dangerous or present peril (usually to the health of humans or animals)

household refuse put-outs – improperly covered household trash cans or plastic bags

illegal dumping – improperly disposing unwanted items of garbage or chemicals in the wrong place

litter – human-generated solid waste lying around in disorder, causing a visual and/or health disturbance

loading dock source – the debris scattered by the constant loading and unloading of vehicles

motorist source – waste that is thrown from or falls from cars and trucks

pedestrian source – waste dropped or thrown by people standing or walking

recycle – the act of collecting and separating materials and products from the solid waste stream and reusing them as raw materials in manufacturing processes

recycling bin – a storage receptacle used to collect recyclable materials

uncovered vehicle source – materials that blow out or fall from trucks or trailers if they are not covered or tied down

waste material – something that is no longer wanted or needed

Overview – THE TROUBLE WITH LITTER



Activity 1: Fishing for Litter Habits

Description

Students “fish” for litter habits in a fishing game that uses a “pole” made from a ruler, string and magnet. Paper clips attached to the fish are attracted to the magnet at the end of the fishing pole. When students “catch” a litter habit, they read it and *infer* whether to place it in the good habit section or the bad habit section. Students *graph* the habits at the end of the activity.

Ohio Proficiency Test Learning Outcomes

Grade 4, Math #23 – Collect data and create a picture or bar graph representing the data.

Grade 4, Reading #12 – Use graphic aids – a table, graph or illustrations to locate or interpret information.

Grade 4, Reading #14 – Identify and interpret vocabulary words, phrases or expressions critical to the meaning of the text.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Summary

This lesson includes three activities. The activities may be used separately and in any order. The background information should be presented before conducting any of the activities.

Activity 2: A Lot of Litter

Description

A two-act play, read by students in class, teaches the sources of litter. In the play, a family solves a litter problem in their neighborhood. In Act II of the play, most of the litter habits are described in litter poems. Students *speak* clearly and *listen* carefully as they *communicate* their message to the audience.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #15 – Identify or explain the purposes of local government.

Grade 4, Citizenship #17 – Identify and assess the possibilities of group decision making, cooperative activity and personal indemnity in the community.

Grade 4, Citizenship #18 – Identify the elements of rules relating to fair play.

Grade 4, Reading #6 – Infer from the fictional text.

Grade 4, Reading #7 – Compare and/or contrast elements, such as characters, setting or events.

Grade 4, Reading #8 – Respond to the text.

Grade 4, Science #14 – Identify the relationship between human activity and the environment.



3

Activity 3: Don't Step on Litter

Description

Students *cooperate* in groups as they play a board game. They identify causes of litter and good and bad litter habits as they move from “start” to the “recycling center.” Students *make computations* to move an appropriate number of spaces during the game.

Ohio Proficiency Test Learning Outcomes

Grade 4, Mathematics #8 – Add, subtract, multiply and divide whole numbers and explain, illustrate or select thinking strategies for making computations.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Background Information

Waste material can be found anywhere people live, work and play. Waste that is not properly contained is called **litter**. It is important to learn about litter because people create the problem. Litter, such as paper, cans, food scraps, tires and other waste materials improperly disposed of, can be unsightly and often present a health hazard.

Litter can result from a direct action (throwing trash out the car window) or an indirect action (failing to secure trash can lids tightly). Deliberate littering is an improper form of waste disposal similar to **illegal dumping**. In both cases, harm may be done to the environment in one or more ways, including injury to wildlife and threats to human health.

The environmental impact of litter depends on the nature of the littered items and the characteristics of the land or water where it is deposited. Food scraps, when left in a natural environment in small amounts, may not be harmful to the environment because they become part of nature's recycling system. Food waste on city streets, however, is a health **hazard**.

Human-made materials, such as plastic, glass, steel and aluminum, are both unsightly to the landscape and a potential hazard to wildlife and people. These objects may become a home to disease-spreading insects, such as flies and mosquitoes. They can also cause external injury to animals and humans. For example, it is common for birds to ingest waste materials or become trapped, causing injury or death.

Litter comes from many sources. The following is a list of seven sources of litter, as identified by the Keep America Beautiful organization. It is estimated that 80 percent of all litter originates from the first five sources.

- **Household refuse:** Improperly covered household trash cans or trash contained in plastic bags are a potential source of litter. Animals or people can knock over cans and open bags. Wind can also blow trash from open cans.
- **Commercial refuse:** Stores and businesses generate large amounts of waste. If garbage cans and dumpsters do not have tightly-fitted lids or locks, the waste can be easily scattered.
- **Construction/demolition sites:** Scrap building materials can be blown or carried away from these

areas to become litter if fences are not put around the site and containers with secure lids are not used.

- **Uncovered vehicles:** Material can fall or blow from trucks or trailers creating serious hazards for other motorists. Loads should be tied down or covered with a tarp.
- **Loading docks:** The constant loading and unloading of vehicles can produce all kinds of debris. Storage bins and dumpsters should always be kept closed.
- **Motorists:** Drivers and/or passengers create litter when they throw waste from their vehicles. Car litter bags and trash cans conveniently located at parks, rest areas, gas stations and fast food stores help reduce this type of litter.
- **Pedestrians:** Waste is often dropped or thrown on the ground by people on foot. Containers along sidewalks and in recreation areas provide an opportunity to avoid littering.

Littering isn't just unsightly, unhealthy and wasteful; it's illegal. Under Ohio law, litter is any trash thrown, discarded or dropped by a person onto public property, private property not owned by the individual, or into Ohio's waterways. Littering is a serious offense, punishable by fines up

to \$500 and 60 days in jail.

Law enforcement officers can issue tickets for casual littering from motor vehicles as they do for traffic violations, such as speeding. In addition, the driver of a motor vehicle or watercraft can be held responsible for litter discarded onto the roadway or waterway by passengers.

It is also illegal in Ohio to drive or move a vehicle on any highway with a load that is not secured. All loads that can spill or drop litter on the roadway require a covering. Exceptions to this law include farm vehicles used to transport agricultural products and garbage collection vehicles in the process of acquiring their loads.

Illegal dumping is a serious aspect of littering. Not only is dumping waste

on private or public land and waterways prohibited, but it is illegal to use someone else's dumpster. Citizens should use licensed disposal facilities and insist that trash haulers use legal disposal methods.

Learning about litter can have a positive impact. Children can do their part, by not littering and by picking up litter when it is safe to handle. Most importantly, they can discourage others from littering.

Bibliography and Additional Resources

Student Resources

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What We Can Do About Litter, by Donna Bailey, New York: Franklin Watts, 1991.

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Facts Not Fear by Michael San Era and Jane S. Shaw, Washington, DC: Regnery Pub. Inc., 1996.

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Activity 1

Fishing for Litter Habits

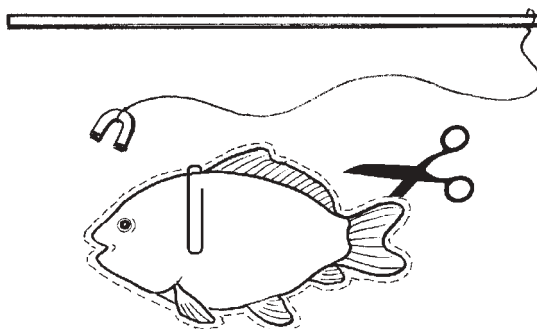
Objectives

Students will be able to: (a) distinguish between good litter habits and bad ones; (b) create a bar graph to demonstrate results; and (c) read statements aloud pertaining to good and bad litter habits.

Preparation

Copy, cut out and laminate the handout, *Litter Habits Fish 1-4*.

Make a "fishing pole" by attaching a 3-ft. long string to a ruler. Attach a magnet to the other end of the string. Place paper clips on each cut-out litter habit fish. See illustration at right.



THE TROUBLE WITH LITTER

Inquiries

- What are some bad litter habits and why are they bad?
- What are some good litter habits and why are they good?

Content Domain

Language Arts – Reading

Math – Arithmetic

Science – General Science

Learning Outcomes

Math, Grade 4, #23

Reading, Grade 4, #12, #14

Science, Grade 4, #14

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THE TROUBLE WITH LITTER

Duration

50 minutes (not including preparation of “litter fish”)

Materials

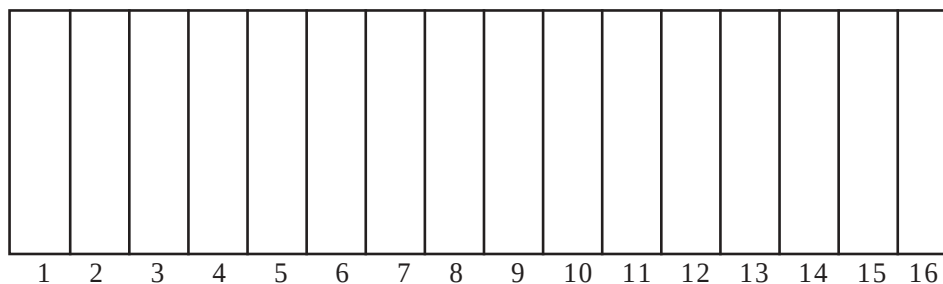
Cut-out litter habits (laminated, if possible), **paper clips**; **small stick** or **ruler**; **string**; **magnet**; **two large, clear plastic ziplock bags** (labeled “good habits” and “bad habits”)

Handouts

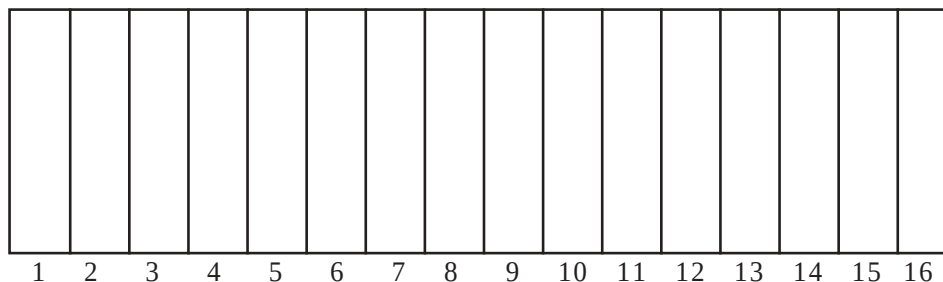
- *Litter Habits Fish 1-4*

Draw a simple graph on the board, chart or overhead. See example below.

Good Habit



Bad Habit



Procedure

1 Explain to students that they are going fishing today, but instead of fishing for real fish, they are going to fish for litter habits. Tell students that each fish represents a habit, and before the “fishing” starts, ask them to give an example of a bad litter habit, followed by an example of a good one.

2 Tape large, clear ziplock bags to the chalkboard (one labeled “good habits” and one labeled “bad habits”). Students take turns “fishing” for litter habits. When one is “caught,” the student reads it to the class and decides whether it belongs in the good habits or bad habits bag. Student explains why the habit is good or bad.

3 The student goes to the graph and colors in green for good habit or red for bad habit.

ANSWERS: 1. bad, 2. good, 3. good, 4. bad, 5. bad, 6. bad, 7. good, 8. bad, 9. bad, 10. good, 11. bad, 12. good, 13. bad, 14. good, 15. bad, 16. good, 17. bad, 18. good, 19. good, 20. good

Assessment

Method A: Have students make a poster urging others not to litter.

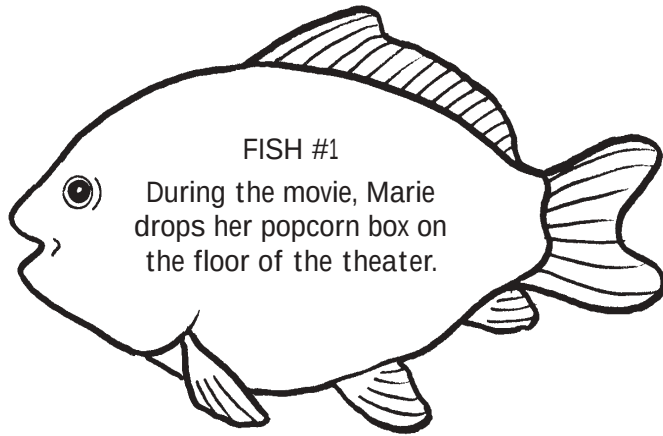
Method B: Give each student two blank fish and have him/her create one good litter habit and one bad litter habit.

Extensions

1 This lesson can be used in conjunction with a magnetism unit.

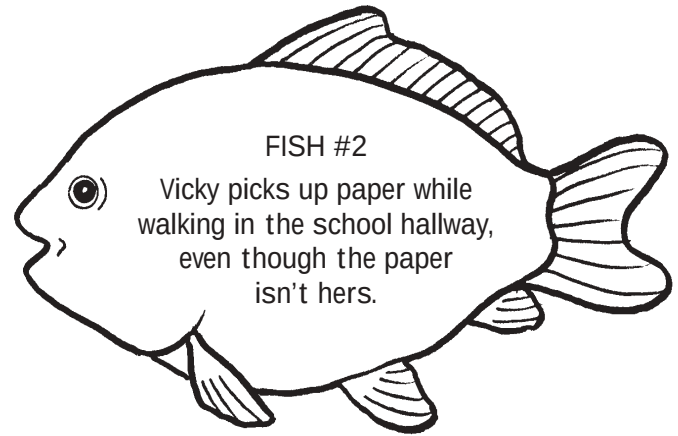
2 Students can also make up their own litter fish and take the game to other classrooms.

LITTER HABITS FISH I



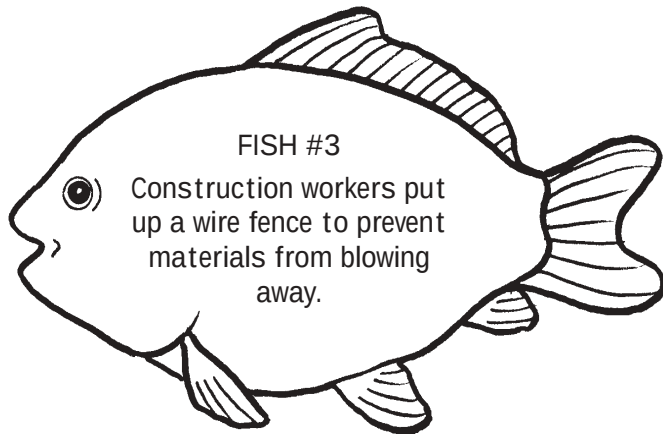
FISH #1

During the movie, Marie drops her popcorn box on the floor of the theater.



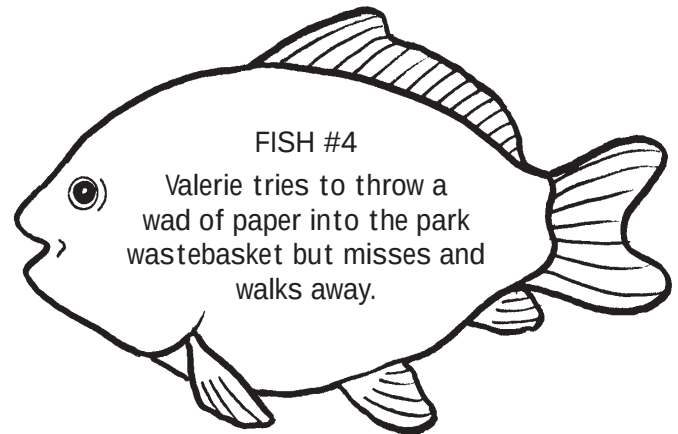
FISH #2

Vicky picks up paper while walking in the school hallway, even though the paper isn't hers.



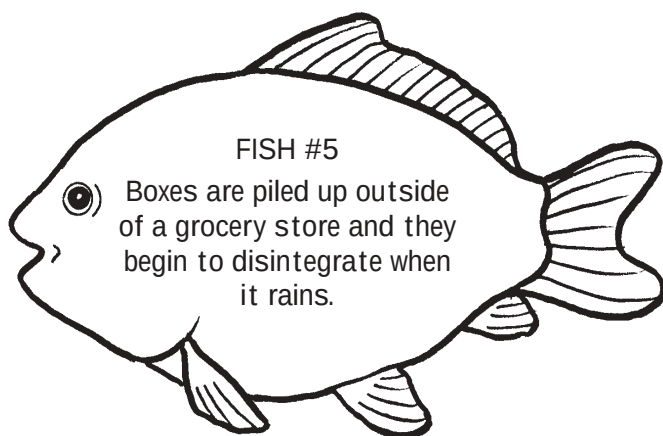
FISH #3

Construction workers put up a wire fence to prevent materials from blowing away.



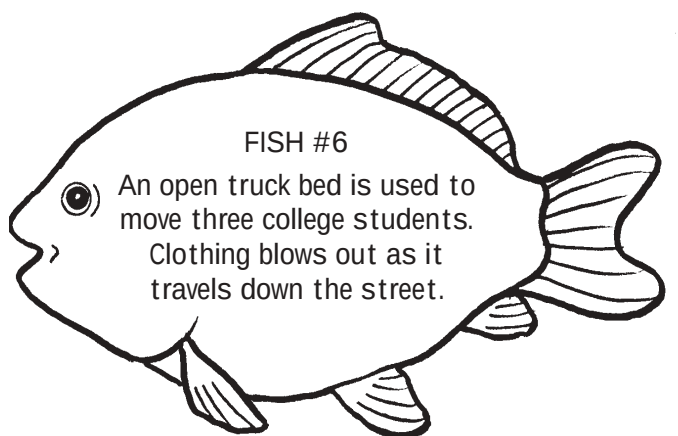
FISH #4

Valerie tries to throw a wad of paper into the park wastebasket but misses and walks away.



FISH #5

Boxes are piled up outside of a grocery store and they begin to disintegrate when it rains.



FISH #6

An open truck bed is used to move three college students. Clothing blows out as it travels down the street.

LITTER HABITS FISH 2

FISH #7

Jeff crushes all aluminum cans in his household and takes them to the recycling center once a month.

FISH #8

After eating at a drive-thru restaurant, Jerry throws his cup and napkin out the car window.

FISH #9

Mary and Ted go on a picnic and leave their aluminum cans in the woods.

FISH #10

Scouts go on a hike in a park. They pick up litter as they walk.

FISH #11

A large dumpster is left open and trash blows out.

FISH #12

Terry and his father pick up litter along a highway.

LITTER HABITS FISH 3

FISH #13

Sandy Smoker throws her cigarette butts on the ground.

FISH #14

Joe watches a movie at the cinema. After the movie is over, he takes his candy box with him and throws it in the trash can.

FISH #15

Wood scraps and nails are left outside of a new house. Children play nearby.

FISH #16

Amy puts a covered trash container out the morning of trash day. She takes the empty container back to the house at night.

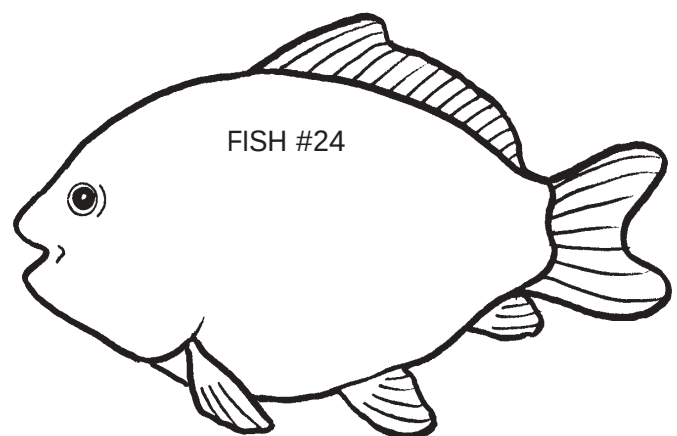
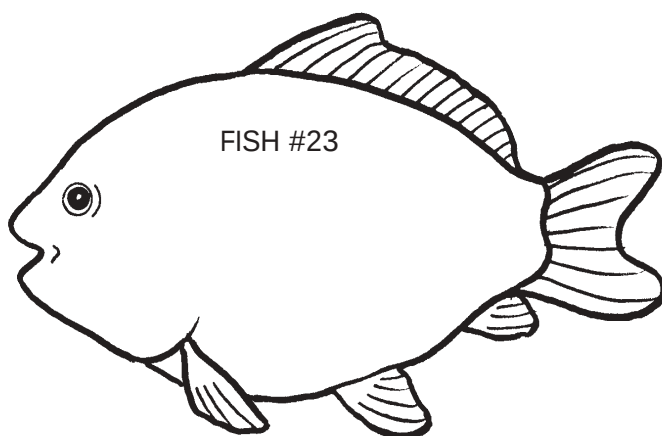
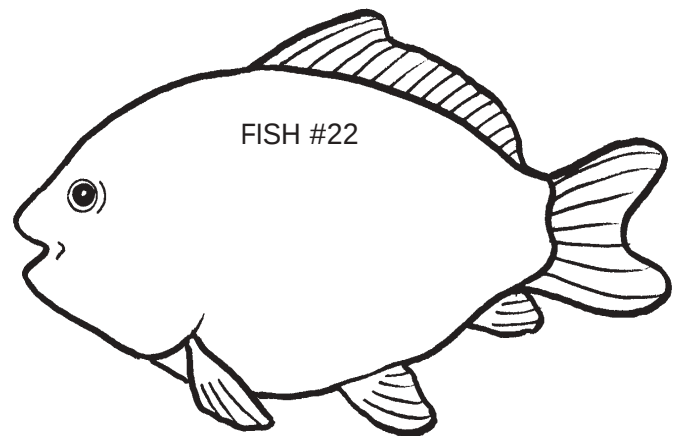
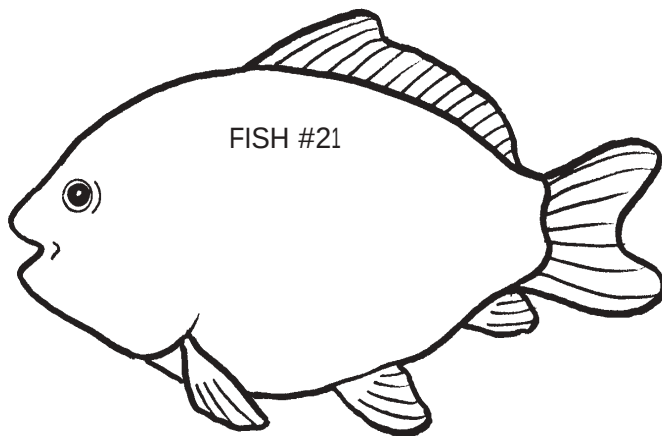
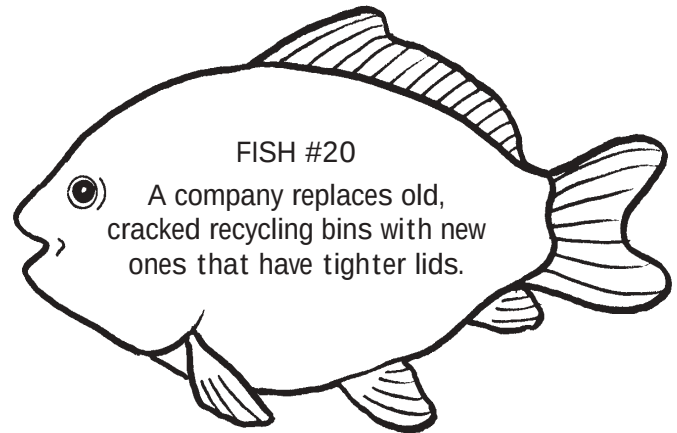
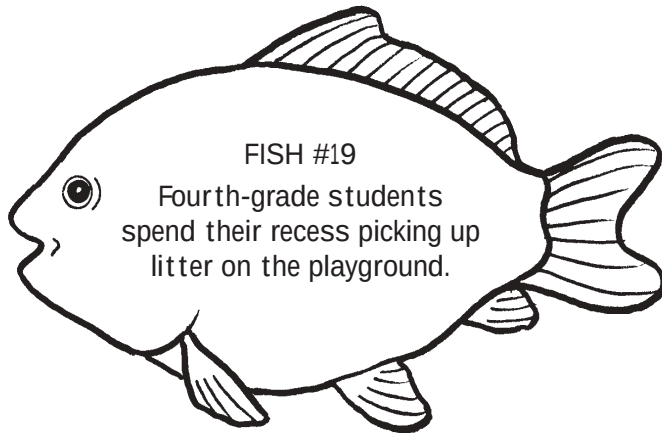
FISH #17

Sam puts the trash out, but he doesn't put the lid on the garbage can. Trash blows out during the night.

FISH #18

The manager of a drive-thru restaurant walks around the building picking up paper and containers.

LITTER HABITS FISH 4





A Lot of Litter

Objectives

Students will be able to: (a) identify sources of litter as they read through a play; (b) take a leadership role and address public issues as they deliver a presentation to their peers; and (c) identify and assess the possibilities of group decision making, cooperative activity and the elements of the rules of fair play.

Preparation

Copy the play (one per student). Props are needed if the play is performed for an audience. Each “source of litter” character will need to hold a sign that has the poem they’ll be reciting on the back. For example, on the front of the sign, print their character with a bold marker, so when the student reads the poem, the name of the character (COMMERCIAL SOURCE) faces the audience.

Procedure

- 1** Using the Background Information, discuss the causes of litter with the class.
- 2** Distribute copies of the play and assign parts.
- 3** Read through the play. Before reading Act II, which takes place at a city council meeting, pause for a short discussion. Talk about local government and the democratic process. Explain to students that the family in the play uses the city council to help them solve a problem and improve the community.

4 Finish reading the play. Discuss the sources of litter emphasized in the play.

5 Discuss the play and make any needed changes that would improve it.

6 If students will be performing the play for other classrooms or other audiences, discuss props, costumes and encourage creativity in performing the play. If needed, find and/or make the costumes and props.

7 After several practices, perform the play.

Assessment

Assessment is embedded in the performance of the play by evaluating the speaking, listening and delivery of a presentation to peers.

Extensions

1 The play can be performed in one short period by reading the litter poems in Act II only.

THE TROUBLE WITH LITTER

Inquiries

- What are the sources of litter?
- What can children do to solve a litter problem in their neighborhood?

Content Domain

Citizenship – Government

Language Arts – Reading, oral communication

Science – General science

Learning Outcomes

Citizenship, Grade 4, #15, #17, #18

Reading, Grade 4, #6, #7, #8

Science, Grade 4, #14

Duration

60 minutes

Materials

Copies of the play (one per student); **props for the play** (litter items, baseball mitts, baseball, etc.); **10 pieces of cardboard or chart paper** (12 x 18 in.); **markers**; **two long tables** (or use several desks); **chairs** (one per student)

2 After reading the litter poems in Act II, have students write their own poems to describe the seven litter sources.

3 Students can write to government officials and share their own ideas of reducing littering.

A LOT OF LITTER

Cast of Characters:

Greg	Pedestrian Source
Kelly	Loading Dock Source
Mom	Motorist Source
Dad	Commercial Source
Kitten	Construction Source
Council President	Extras
Council Member 1	
Council Member 2	Group Choral Chant
Council Member 3	Members (<i>consists of the</i>
Council Member 4	<i>remainder of the class or group</i>
Household Refuse Source	<i>along with the “Sources of</i>
Uncovered Vehicle Source	<i>Litter” speaking together)</i>

ACT I

TIME: Early spring, the present

SETTING: An empty lot, filled with litter and trash items (such as cans, plastic bottles, newspaper, broken toys, old furniture, tires, boxes, etc.).

STAGE DIRECTIONS: Greg and his younger sister Kelly enter from stage left, followed by their parents (Mom, Dad). They've been playing baseball at the ball field, which is next to the littered lot.

GREG:

I think the ball went this way (*crosses stage and rummages through junk to locate baseball*).

KELLY:

Wow, look at this place. It's a junkyard.

MOM:

(*enters stage left*) Greg, did you find...(stops) This place sure has changed.

DAD:

(*yelling from off stage*) Hey, where did all you guys go?
(*enters behind Mom*) Oh, here you are.

MOM:

(*turns to Dad*) Adam, look at how run-down this lot is. Remember when we were kids, it was the perfect place to play kickball?

KELLY:

You and Dad played here? No one plays here anymore.

GREG:

Yeah, we don't go any farther than the ball field...too much junk.

MOM:

You're right, you shouldn't play here, but 10 to 15 years ago, it was as nice as the ball field over there. I guess times have changed.

DAD:

It's a shame when you think about how much more room kids would have to play ball, if they cleaned up this place.

KELLY:

(*walking around the lot*) Who let people throw all this junk here? Shouldn't there be a law or something?

GREG:

Who cares? Let's find the baseball and get back to our game.

MOM:

That's the problem Greg. No one cared enough to keep the place clean. All it takes is one person to start littering and a few years later, you've got an illegal dumpsite.

DAD:

Mom's right. People tend to litter where they already see litter. It doesn't take long before a nice grassy lot turns into (*points around*) this.

KELLY:

Yeah, kind of like Greg's bedroom (*everyone laughs, but Kelly stops to listen to meowing from stage right*)

KITTEN:

Meow (*Kitten is curled up in box, not seen by audience*).
Meow, meow.

KELLY:

Hey, did anyone hear that? I think it's a cat.

DAD:

Kelly, I hear it. (*Dad walks toward the kitten, clearing trash and debris out of his way.*) I think it's coming from over here in this old box. (*Kitten crawls out of box with wire or electrical cord wrapped around entire body, limps toward Dad and Kelly.*)

KITTEN:

Meow, meow.

KELLY:

(*She rushes past Dad to Kitten.*) It's stuck in the wire (*cord*) and looks hurt. Dad, help me untangle the wire. (*Greg also goes over to help, and moves garbage out of their way.*)

MOM:

(*She helps too*) You kids should learn from this. Litter isn't just ugly, it's dangerous. (*She puts the tangled wire back in the box where Kitten was.*)

GREG:

(petting Kitten who settles down to nap on the ground)
The wire's all off and the cat looks okay. And, here's my baseball.

KELLY:

Can't we do something so that more animals and people won't get hurt?

GREG:

I can't believe I'm saying this, but can't we clean up the lot?

DAD:

(laughing) I want to see that...no, seriously kids, I think cleaning up this lot would be a great community project and I know just the right place to begin.

GREG:

Me too, with lots of trash bags.

DAD:

Not so fast Greg. I think this land is part of the ball field and it belongs to the city. We should go talk to the city council.

KELLY:

Who do we have to call?

MOM:

It'll take more than a phone call Kelly. We can organize a cleanup, but because it's public land, we need to take our plan and present it at the next city council meeting.

DAD:

Are you willing to talk about what we saw today in front of the city council members?

GREG:

I am. Maybe they'll even turn this lot into a playground or something?

DAD:

Now you've got the idea, son. Let's go home and start calling some of our neighbors. *(Mom and Dad start to exit stage left).*

KELLY:

But what about the kitten, can we keep her Mom?

MOM:

We'll have Dr. Evans take a look at her, and then we'll talk about it.

KELLY:

Okay, Mom. *(turns to coax Kitten off stage)* Here, Kitty, Kitty. You're going home with us.

KITTEN:

Meow! *(smiles and purrs)* Meow! *(Licks paw and follows Kelly and the rest of the family as they exit the stage.)*

CURTAIN

ACT II

TIME: Two weeks later.

SETTING: City Council meeting. Members of the council are sitting on the right side of the stage at a long table. (Four desks can substitute for the table.) A podium (this can be made from three stacked boxes) is center stage.

Sources of Litter stand in a row on the left – each holding a sign (i.e., Pedestrian Source of Litter, printed in bold marker on the front of sign and Pedestrian Source poem taped to the back – for easier reading during the performance).

STAGE DIRECTIONS: Kelly and Greg sit on chairs in front of the Sources of Litter. Mom and Dad are seated in the real audience and come up to the podium when called.

COUNCIL PRESIDENT:

Ladies and Gentlemen, we are ready for comments and/or suggestions from the citizens in the audience.

DAD:

(Comes up on stage with Mom. Both parents stand at the podium.) Ladies and gentlemen of the council, thank you for letting us come here today to present our idea. Our children have been looking into some ways of cleaning up the vacant lot behind the city ball field.

MOM:

It has turned into an illegal dumpsite and they'd like to change that. Greg and Kelly, will you come forward?

GREG:

My sister Kelly and I researched the problem of litter and thought a skit could explain it best. Our friends are going to help us tell you how litter happens. We're also going to do the skit at school for our Earth Day project.

KELLY:

Greg and I asked each person to be one source or cause of litter. By learning the causes of a problem, we can prevent the problem from happening again. We'll start with a source or cause of litter that we all know well- the garbage can *(formally known as the Household Refuse Source)*.

HOUSEHOLD REFUSE SOURCE:

Hi! I'm household refuse, better known as the garbage can. This rhyme will help all of us understand the problem with me.

Oh, Michael put the trash out.
The trash was in two bags.
Mom thanked him and he went to bed.
They hadn't thought of Rags.

Rags was loose that very night.
He came by and smelled food.
He chewed one side and left a mess
Not meaning to be rude.

But then the wind began to blow
And trash began to scatter.
No one meant to cause the mess.

How can we change this matter?
Dad bought covered trash cans
And a nice recycling bin.
The next week when the trash went out
Everything stayed in.

While Haleigh waited for her bus
She saw a shiny can.
It had rolled there from Michael's yard.
Now Haleigh had a plan.

This good girl took it right to school.
The moment she went in,
She placed it in its proper place
The school recycling bin.

GROUP CHORAL CHANT

(Everyone on stage, except the council, chants)

Change a bad habit.
How can you make it good?
Don't let it drop- recycle it
And put it where you should.

UNCOVERED VEHICLE SOURCE:

Hi! I'm Uncovered Vehicle Source and this is my story in rhyme:

The truck went down the highway
Heading toward the rummage sale.
The whole rear cab was loaded
Way up above the rail.

The driver didn't notice
That from the rummage pile
Paper and clothes flew about
Down every single mile.

And these things became litter.
As they landed-there they stayed.
If the driver had just stopped to think
About the mess he'd made.

GROUP CHORAL CHANT:

Change a bad habit
How can you make it good?
Don't let it drop-recycle it
And put it where you should.

PEDESTRIAN SOURCE:

Hello! I'm the Pedestrian Source of Litter, better known as people who litter and here is my rhyme:

The teens played ball after school,
They didn't have a care.
They threw candy wrappers and
Pop cans went everywhere.

A little kitten stopped to play
With pop cans in the field.
Its paw got stuck and badly cut
Don't litter-we repeat.

GROUP CHORAL CHANT:

Change a bad habit
How can you make it good?
Don't let it drop-recycle it
And put it where you should.

LOADING DOCK SOURCE:

Hello! I'm the Loading Dock Source and this is my story:

The loading dock was open
As the truck pulled to the gate.
The cartons were unloaded
But the workers couldn't wait.

They untied all the straps and ropes
And pulled new tables out.
But when the trucker drove away
Debris was strewn about!

GROUP CHORAL CHANT:

Change a bad habit
How can you make it good?
Don't let it drop-recycle it
And put it where you should.

MOTORIST SOURCE:

Hi! I'm the Motorist Source and this is my story in rhyme:

Sue and Bob drive down the street
They're hungry so they stop.
They buy two double burgers
And each one drinks a pop.

They should recycle all the trash
But this is what they do;
They throw the garbage on the street
And now it spoils the view.

It changes all it touches
The road is not so nice.
Next time we hope that Sue and Bob
Will please take our advice.

GROUP CHORAL CHANT:

Change a bad habit.
How can you make it good?
Don't let it drop-recycle it
And put it where you should.

COMMERCIAL SOURCE:

Hi! I'm Commercial Source and this is my story in rhyme:

The sidewalk sale was held in June
And many shoppers came.
But when the sale was over
The place was not the same.

They put the leaflets on the cars
They passed them out all day.
But by the time the sun went down,
The leaflets blew away.

The merchants took the clothing in
But much was left behind.
Leaflets, bags and wrappers
Were left for you to find.

GROUP CHORAL CHANT:

Change a bad habit.
How can you make it good?
Don't let it drop-recycle it
And put it where you should.

CONSTRUCTION SOURCE:

Hi! I'm Construction Source and here's my rhyme.

The building crew worked all week long,
The house grew straight and tall.
The workers put the shingles on
But let the wrappers fall.

Cartons, twine and boxes
Were left out in the yard.
And some of it was scattered,
The crew was caught off guard.

GROUP CHORAL CHANT:

Change a bad habit
How can you make it good?
Don't let it fall-recycle it
And put it where you should.

COUNCIL PRESIDENT:

I'm impressed! You children have gone to a lot of trouble
to show us how litter happens and how we can correct the
problem. Now, what about that illegal dumpsite?

COUNCIL MEMBER 1:

How can we help you. Do you have any ideas?

KELLY:

After we clean up the lot, we're asking the city to let us use
it as a public playground.

COUNCIL PRESIDENT:

Is there any discussion?

COUNCIL MEMBER 3:

Will the children participating in the cleanup be properly
supervised so no one gets hurt?

DAD:

My wife and I will take responsibility for supervising the
clean-up, plus we'll contact the local litter prevention and
recycling office for their help in organizing the clean-up.

COUNCIL PRESIDENT:

Do I hear a motion to turn the vacant lot into a play-
ground if the neighborhood cleans it up?

COUNCIL MEMBER 2:

I move that we let the neighborhood children use the
playground if they organize a cleanup and the place stays
a safe and clean play area.

COUNCIL MEMBER 4:

I second that motion and ask that we vote on the motion.

COUNCIL PRESIDENT:

All in favor signify by saying "aye."

ALL COUNCIL MEMBERS:

Aye.

COUNCIL PRESIDENT:

It's unanimous! The motion carries.

ALL:

Cheer and shake hands.

COUNCIL MEMBER 1:

Council President, at next month's meeting, I'd like to look at fencing in the playground and maybe, find a way to add some playground equipment.

GREG:

Thank you so much.

KELLY:

We hear about it in class all the time, but this really is democracy in action.

COUNCIL MEMBER 4:

Thank you all for working together to make our town a better and cleaner place.

COUNCIL PRESIDENT:

And the next time one of us starts to litter, I'm sure we'll think of your skit and "don't let it drop."

ALL:

(Everyone on stage smiles and chants)

So change a bad habit

How can you make it good?

Don't let it drop- recycle it.

And put it where you should.

CURTAIN

Credits: *A Lot of Litter* was written by Beverly Klimp.



Don't Step on Litter

Objectives

Students will be able to: (a) identify three causes of litter; (b) cooperate in groups to read and follow directions; (c) add, subtract, multiply and/or divide numbers (depending on grade level); and (d) use a parenthesis properly in math computations.

Preparation

Copy the game board and game cards handouts for each group of students. Have students glue the handout, *Don't Step on Litter Game Board*, to a piece of construction paper for added strength. Students should cut out the game cards and shuffle them before the game begins.

Procedure

1 Using the Background Information, discuss how litter negatively affects the environment. Ask students to describe litter and explain why they think litter happens. Discuss the penalties of littering and illegal dumping. Ask students if they have ever littered and why? Using general examples of negative litter habits (for examples, see Activity 1, *Litter Habits Fish*), ask students how these negative litter habits can be changed to positive litter habits.

2 Explain to students they will be playing a game that penalizes players for negative acts of litter and rewards them for positive litter habits. Divide class

into groups of four students and have them assemble the game. Give each group a set of the handouts, *Don't Step on Litter Game Cards* and *Don't Step on Litter Game Board*.

3 Have each group place their game cards, face down, on the desk next to the game board.

4 The first student turns over a card, reads it and computes the number of moves. Everyone in the group should verify that the computation is correct. If it is, the student moves the game marker (old button) forward or back the correct number of moves.

ANSWERS: 1. 5, 2. 7, 3. 6, 4. 2, 5. 3, 6. 6, 7. 6, 8. 5, 9. 7, 10. 5, 11. 2, 12. 4, 13. 1, 14. 3, 15. 1, 16. 1, 17. 2, 18. 4, 19. 1, 20. 1

5 Each player takes a turn in order and turns the used card over in a separate (discard) pile.

6 The first player to reach the recycling center wins. It is not necessary to have the exact number of spaces to reach the recycling center. Students may need to flip the discard pile over and reuse the cards to finish the game.

THE TROUBLE WITH LITTER

Inquiries

- What are some positive litter habits?
- What are some negative litter habits?
- What causes people to litter?

Content Domain

Math – Arithmetic

Science – General science

Learning Outcomes

Math, Grade 4, #8

Science, Grade 4, #14

Duration

45 minutes

Materials

Copies of handouts: *Don't Step on Litter Game Board* and *Don't Step on Litter Game Cards* (one per student); **construction paper** (one 8" x 11" sheet per student); **old buttons** (use a variety) for game **markers**; **scissors** and **glue**

Handouts

- *Don't Step on Litter Game Cards (1-4)*
- *Don't Step on Litter Game Board*
- *Don't Step on Litter Assessment*



Optional: Using the blank game cards, have students create their own cards and trade their new cards with other groups. Use the new cards in a second round.

Assessment

Have students complete the handout, *Don't Step on Litter Assessment*.

ANSWERS: 1. d, 2. b, 3. a, 4. b, 5. c, 6. b

Extensions

1 A whole class game can be played by using the game board on an overhead projector. Before the game begins, make a transparency of the game board. Use shapes to represent team pieces (i.e. triangle team, circle team). Divide the class into two groups and line up each group on opposite sides of the room. The first student in each line comes forward and turns over a game card. The student then moves the game marker on the overhead and goes to the end of the line.

2 Have each student make a set (game board and cards) to take home.

Student Handout



DON'T STEP ON LITTER GAME CARDS-I

1

You recycled your plastic milk jugs.
Move ahead $(3+4) - 2$ spaces.

**2**

You recycled your old aluminum
cans. Move ahead $(3-1) + 5$ spaces.

**3**

You recycled empty glass jars.
Move ahead $(3+5) - 2$ spaces.

**4**

You recycled a cardboard box. Move
ahead $(6+6) - 10$ spaces.

**5**

You stacked and recycled your
family's old newspapers.
Move ahead $(10-5) - 2$ spaces.

**6**

You rinsed and recycled a dozen steel
cans. Move ahead $(6+8) - 8$ spaces.





DON'T STEP ON LITTER GAME CARDS-2

7

You reused the back of old notebook paper. Move ahead $(9-4) + 1$ spaces.

**8**

You packed your lunch in reusable containers. Move ahead $(9-7) + 3$ spaces.

**9**

You sold your old toys at a garage sale instead of throwing them away. Move ahead $(2+2) + 3$ spaces.

**10**

Your family bought paper towels made from recycled paper. Move ahead $(6+3) - 4$ spaces.

**11**

You picked up the litter along your street. Move ahead $(14-7) - 5$ spaces.

**12**

You dropped your candy box on the movie theater floor. Move back $(7-5) + 2$ spaces.



Student Handout



DON'T STEP ON LITTER GAME CARDS-3

13

You pitched your hamburger wrapper out the car window.
Move back (9-6) - 2 spaces.

**14**

Sandy Smoker throws cigarette butts on the ground.
Move back (8-6) + 1 spaces.

**15**

At the picnic in the park, you left your paper plates and cups on the ground. Move back (9-5) - 3 spaces.

**16**

When you moved, your family forgot to cover the back of the truck and your clothes fell on the road.
Move back (6-4) - 1 spaces.

**17**

You set out open, plastic garbage bags for trash pickup.
Move back (8-4) - 2 spaces.

**18**

You gave away old magazines and books to your local library.
Move ahead (9-4) - 1 spaces.





DON'T STEP ON LITTER GAME CARDS-4

19

After fishing, you leave the extra fishing line along the bank of the river.
Move back (9-3) - 5 spaces.

**20**

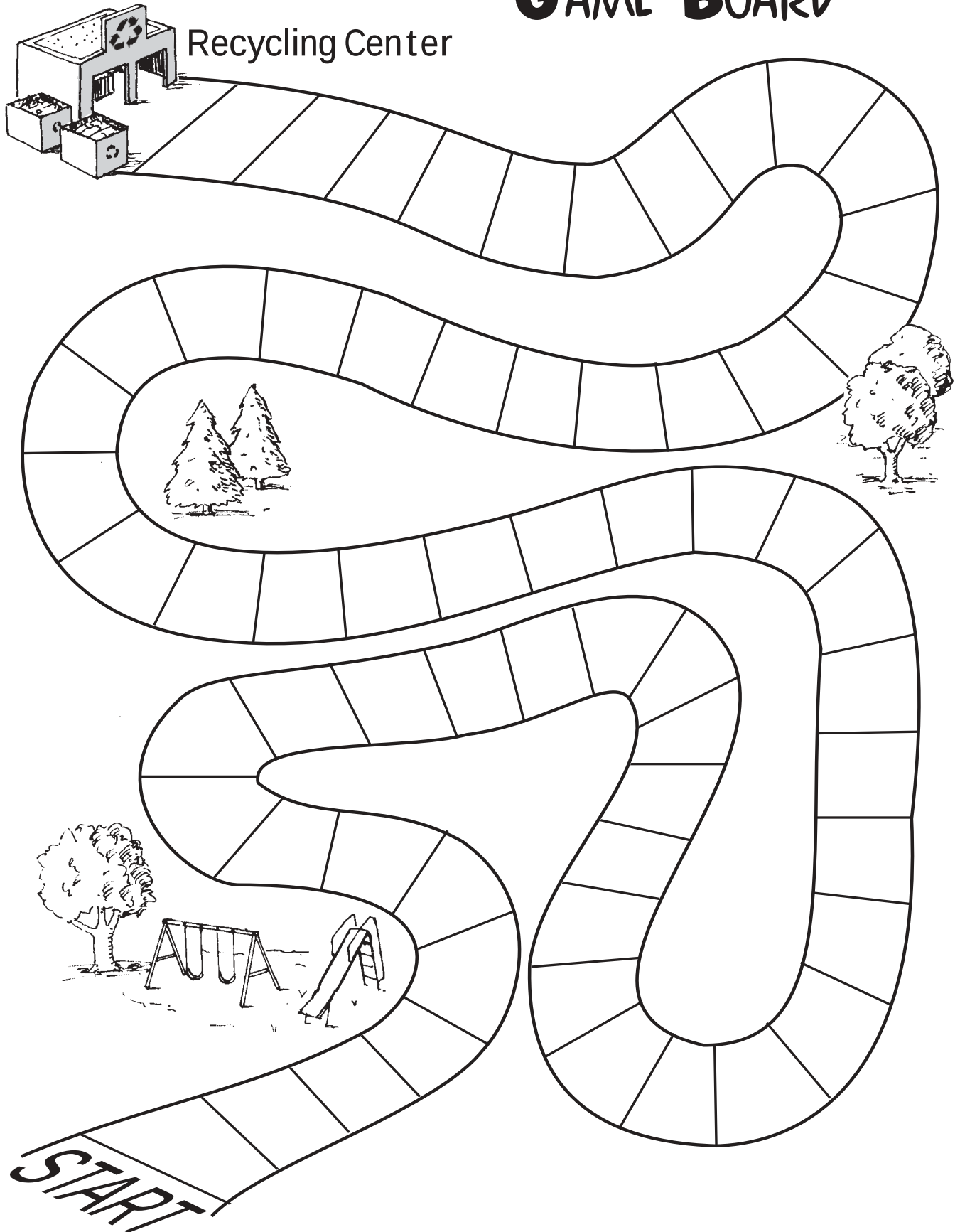
After Randy Roofer put a new roof on your house, he left packaging and nails in your yard.
Move back (6-3) - 2 spaces.

**21****22****23****24**

Student Handout



DON'T STEP ON LITTER GAME BOARD



Student Handout



DON'T STEP ON LITTER ASSESSMENT

Directions: Put the correct letter in the blank space beside each question.

- _____ 1. An example of a good litter habit is:
- a. throwing paper out of a car window
 - b. putting aluminum cans in a dirty yard
 - c. walking around old papers on the sidewalk
 - d. picking up papers along the highway
- _____ 2. An example of a bad litter habit is:
- a. taking cans to a recycling center
 - b. allowing papers to fall out of a car or truck
 - c. picking up litter in the park
 - d. going on a picnic
- _____ 3. The answer to this math operation: $(6+4)-8=$ _____
- a. 2
 - b. 18
 - c. 10
 - d. 3
- _____ 4. The answer to this math operation: $(15-8)+6=$ _____.
- a. 29
 - b. 13
 - c. 2
 - d. 15
- _____ 5. The answer to this math operation: $(9-5)+7=$ _____.
- a. 21
 - b. 10
 - c. 11
 - d. 20
- _____ 6. The answer to this math operation: $(15-6)+5=$ _____.
- a. 16
 - b. 14
 - c. 26
 - d. 15



TRASH MAKES HISTORY

Environmental Studies Learning Concept

Human settlements have developed over time from simple cultures of hunters and gatherers and pioneers to more complex cultures defined by industrial technology and the growth of cities. Technology and the socio-cultural values that determine people's wants and needs play a major role in determining a society's relationship with the environment. Historically, social and technological development, or "progress," has led to greater material abundance and increased the potential for environmental degradation and the exploitation of natural resources. However, historical development alone is not a necessary cause of environmental problems. Throughout the history of human settlements, some societies that experienced increasing wealth and population growth eventually exploited resources and degraded the land in ways that diminished the society's ability to sustain development.

Waste disposal, much like sanitation, is an urban environmental concern that has a long history dating from the development of the first cities. Recycling, which is part of this history, is a resourceful economic activity and a method of solid waste management, resource conservation and pollution prevention.

Vocabulary

commercial waste – waste discarded from businesses and institutions, such as schools, hospitals and governments, including non-process industrial waste

consumption – the act of buying and using a resource or product

developing society – a society where farming is the main way of life and industry is only growing slowly

disposal – the process by which waste is prepared for its final containment or destruction

dump – a site where mixed wastes are deposited without controls or regard for the protection of the environment

environment – the sum total of conditions, physical and biological, in which organisms live

garbage – organic refuse consisting of food waste

hazardous waste – waste that may pose a threat to human health or the environment

incineration – solid waste disposal method whereby refuse is burned

industrial pollution – waste and emissions from factories, including hazardous materials, particulate matter and waste water that generates land, air and water pollution

industrial society – a society where large-scale industrial technology is applied to manufacturing and agriculture to represent the main source of jobs and wealth creation

land disposal – the most widely used method of solid waste disposal whereby garbage and trash are dumped in the open, or buried and covered with soil in a landfill

municipal solid waste – solid waste generated at residences, commercial establishments and institutions

natural resources – living and non-living matter that provide energy and materials to sustain life on Earth

pollution – any substance added to the environment that interferes with and/or harms natural processes

primitive society – the earliest societies where technology takes the form of simple tools made from materials found in the natural environment

recycling – using or processing materials (or energy) more than once

residential waste – trash and garbage discarded from homes

reuse – using a product in the same form more than once

solid waste – discarded solid materials from community activities, industrial and commercial operations

trash – dry waste materials considered worthless

Overview – TRASH MAKES HISTORY



Activity 1: Everybody is an Expert

Description

Students *cooperate in groups* and *conduct research* to *identify* and *describe* socio-cultural phenomena in four cultures in American history: Native American culture, pioneer culture, industrial culture and modern (contemporary) culture. Students record research information to answer questions (on a handout) about social life, natural resource use and waste management. This information can also be used by students to construct a timeline. They *manipulate materials* and *write* passages to make displays about the cultures and their relationships with the environment.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #1 – Demonstrate knowledge of an ability to think about the relationship among events by: (a) identifying sequence of events in history; (b) grouping events by broad historical eras on a timeline; and (c) recognizing that changes occur in history, identifying cause and effect relationships.

Grade 4, Citizenship #2 – Identify and use sources of information about a given topic in the history of Ohio and the United States.

Grade 4, Reading #19a – Choose materials related to purpose, as evidenced in part by the capacity to choose or identify reference resources to locate specific information.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Citizenship #1 – Demonstrate knowledge of and ability to think about relationships among events.

Grade 6, Citizenship #2 – Utilize a variety of resources to consider information from different perspectives about North America.

Grade 6, Reading #16 – Select information from a variety of resources to support ideas, concepts and interpretations.

Grade 6, Science #4 – Identify the positive and/or negative impacts of technology on human activity.

Summary

This lesson includes three activities. Although they may be conducted separately, the activities follow a logical order for understanding the various concepts.

Activity 2: Secrets in a Garbage Can

Description

Students develop *group discussion* skills to *make inferences* about “secrets” revealed by items from a family’s trash. In groups, they examine different waste items and complete a chart to *analyze* what each item says about social wants and needs, the technology of society and the relationship of society to the environment (including resource use, waste management and environmental degradation). The same process can be applied to four historical societies by using waste items specific to each of the societies.

Ohio Proficiency Test Learning Outcomes

Grade 4, Science #1 – Create and use categories to organize phenomena.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Science #3 – Make inferences from observations of phenomena and/or events.

Grade 6, Science #4 – Identify the positive and/or negative impacts of technology on human activity.



Activity 3: Throwaway Societies

Description

Students *read* and *speak* parts of a script that describes how various societies in Western culture have managed their wastes. They *make inferences* about information from the script to design props and *manipulate materials* to make the props. Following the presentation of the skit, students *make deductions* to sequence cultural waste management information onto a timeline. They *discuss* the effects of each disposal method upon the environment.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #1 – Demonstrate knowledge of an ability to think about the relationship among events by: (a) identifying sequence of events in history; (c) recognizing that changes occur in history; and (d) identifying cause and effect relationships.

Grade 4, Science #14 – Identify and/or describe the relationship between human activity and the environment.

Grade 6, Citizenship #6 – Draw inferences about the experiences, problems and opportunities that cultural groups have encountered in the past.

Background Information

Waste disposal is a concern that has a long history, dating back to the establishment of the first cities. Prior to the development of cities, human beings in primitive societies disposed of trash by leaving it where it fell. That practice was adequate because hunter-gatherers frequently moved their camps in order to follow game or to find a new growth of plants. When people settled in groups by practicing farming and erecting cities and towns, the management of **garbage** and **trash** became problematic.

Early urbanites developed four methods of managing waste that are still used today. They include: **land**

disposal (open dump or landfill); disposal by **incineration** (burning waste); **recycling** (turning waste into something useful, including recycled-content products and compost); and **source reduction** (minimizing the volume of goods to be discarded).

Technology and social development dictates how a society generates and manages waste. The types of waste products and materials generated by a society can tell us a lot about the nature of a society including its people's wants and needs; the state of technology; and its relationship with the environment, including natural resource use and environmental degradation. Four types of social development in American and Ohio

history can be identified and analyzed, beginning with Native Americans.

Native Americans, possessing the technology of **primitive societies**, had a minimal effect on the **environment**. They hunted animals for food and fur, gathered plants for food and dye, used plant and animal products to make their shelters, used clay from the Earth to make pots, and chiseled stones for weapons. They sometimes changed the landscape to develop trails and clear areas for agriculture.

As early European settlers in America established agricultural settlements and cities, they had a bigger impact upon the environment. This

developing society harnessed water power, animal power and used tools not known to primitive societies. After the Revolutionary War ended in 1781, westward expansion began; forests were cleared, wetlands were drained and grasslands were plowed to permit farming. By 1820, much of the land east of the Mississippi River was being farmed and cities were cropping up along major land and water transportation routes.

With the advent of the Industrial Revolution in the nineteenth century, settlers began to change the environment in ways earlier pioneers could not have foreseen. As our country developed into an **industrial society**, businesses burned coal to produce steam to power machines to make more consumer goods. Ready-made clothes, commercial packaging (tin cans, corrugated cardboard, glass jars), factory-cut lumber and other mass-produced items were developed by the end of the nineteenth century to generate a consumer society compatible with industrial production.

An abundance of waste materials and pollution followed in the wake of this development. **Industrial pollution** and **hazardous wastes** were generated during mining and manufacturing operations that affected water, air and land. Polluted water killed fish and other aquatic life forms and reduced the amount of clean water for drinking, cleansing and recreational purposes. Polluted land reduced the fertility and productivity of the soil. Polluted air accumulated in the lungs of humans and animals, and caused health problems. In addition to industrial wastes, **residential waste** and **commercial waste** was generated in increasing amounts in cities and towns and became known as **municipal solid waste**. These are all problems, related to technology and the environment, not experienced by primitive and pioneer societies.

Modern society, or contemporary society, has continued industrial development. Since 1945, the development of new technologies, such as atomic power and computers, have led many historians to conclude we are entering a new age – a post-modern or post-industrial era. As new technologies and chemicals are introduced, they may pose new threats to the environment and demand modern management practices.

To meet the challenges posed by pollution in the modern era, new technologies have been developed to control pollution in mining, manufacturing and waste disposal. Businesses and consumers are helping to change the way they operate by consuming less, **reusing** and **recycling** more materials and purchasing environmentally-friendly products.

Bibliography and Additional Resources

Student Resources

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TRASH MAKES HISTORY

Inquiries

- How have people living in different time periods, in Ohio and North America, used the land and natural resources?
- How have different societies managed their waste in Ohio and U.S. history?
- How has the relationship between people and the environment changed in Ohio and U.S. history?

Content Domain

Science – General science

Social Studies – American history, Ohio history

Learning Outcomes

Citizenship, Grade 4, #1, #2 and Grade 6, #1, #2

Reading, Grade 4, #19a and Grade 6, #16

Science, Grade 4, #14 and Grade 6, #4

Duration

Part A: 45-60 minutes, plus research time

Part B: 45 minutes, plus display development time

Materials

Part A: index cards, pen or pencil for each student, reference material about Ohio and U.S. history

Part B: various items (artifacts) to represent each of the four historical time periods

Handouts

- *You are the Expert*
- *Pre- and Post-Test*
- *Trash Timeline*

Activity 1

Everybody is an Expert

Objectives

Students will be able to: (a) identify specific features of social life in various time periods in Ohio and U.S. history; (b) compare resource use and waste management practices in four socio-historical periods in Ohio and U.S. history; and (c) sequence phenomena and events about society and environmental concerns on a timeline.

Preparation

Using the information from the Background Notes on p. XIII-8, make a set of “expert” cards for each of the four historical periods (Native American, Pioneer, Industrial, Modern). Each 3”x 5” or 4”x 6” card should carry one bit of information about one historical period in relation to one or more of the following categories: land and natural resource use, occupations, things made from natural resources, types of waste created, waste disposal practices and people’s relationships to the environment. See sample cards on p. XIII-7.

Procedure**PART A**

- 1 If the *Pre- and Post-Test* is used, have students complete it.
- 2 Divide the class into historical groups. Each group should represent one of the following socio-cultural time periods: Native American, Pioneer, Industrial and Modern. Historically, these eras represent the growth of Ohio and America from a simple to a complex culture.

NOTE: The group(s) that have Modern Culture should examine cultural phenomena from 1945 to today, although questions and concepts in the activity are past tense.

- 3 Give each student the handout, *You are the Expert*, one or two of the pre-made “expert cards” from his/her historical period, and several blank index cards. Also, indicate to students which reference materials are available about Ohio and U.S. history.
- 4 Have each student share the information from his/her “expert cards” with the group. Students can use this information to answer questions on the handout, *You are the Expert*.
- 5 Have students use the available reference materials to acquire more information to answer the questions on the handout, *You are the Expert*. Have students write questions on their blank cards that will help them complete the handout, *You are the Expert*. After they record information from the reference material onto their cards, students can share their new information with their group and complete the handout.

Sample “Expert” Cards - Consider using a different color card for each historical period, so the cards can be easily separated at the end of the activity.

NATIVE AMERICAN CULTURE

- Q. What types of things were created using natural resources?
- A. cooking utensils and baskets

INDUSTRIAL CULTURE

- Q. What types of things were created using natural resources?
- A. automobiles and radios

PIONEER CULTURE

- Q. What types of things were created using natural resources?
- A. homes and furniture

MODERN CULTURE

- Q. What types of things were created using natural resources?
- A. computers and plastic toys

6 In chronological order, ask groups to present their information. Discuss with students how the pioneer culture shared certain traits with Native American culture in regards to natural resource use and waste generation, which sharply contrasts with the industrial and modern cultures' experiences.

7 Have the entire class construct a timeline using the information from their expert cards. Integrate this timeline with others used in class or construct it as part of a multiple-tier timeline. Have students identify cause and effect relationships and the significance of environmental actions in the context of other events.

PART B

1 Have groups create tabletop displays by designing informative posters

and artifacts representative of each socio-cultural time period.

2 To help give students ideas for their displays, collect and display a variety of artifacts representative of different time periods. For example: arrow head, pieces of flint, sharpened stick, Indian beads or needle made of bone from *Native American culture*; iron skillet, patchwork quilt, tin cup, from *pioneer culture*; newspaper, old typewriter, tin can, glass soda bottle from *industrial culture*; packing foam (peanuts), video tape, plastic bottle, push button telephone, pesticide spray from *modern culture*.

3 Students observe and identify each type of society that might have used and discarded each item. They should choose the society (Native American, Pioneer, Industrial or Modern) that reflects the earliest historical use of the item.

4 Discuss the following: What can these artifacts tell us about the societies they are from? What do they say about their use of natural resources, their relationship with the environment and the waste they generated?

Assessment

1 Collect the handout, *You are the Expert*, and grade them for completeness.

2 Administer the *Pre- and Post-Test*.

Extensions

1 Construct a timeline using the information on the teacher page, *Trash Timeline*. Discuss each fact and have students, in their own words,

transfer the information onto cards that can be put on a timeline. Ask students why most of these facts and events relate to industrial and modern times.

2 Have students write a poem or song that tells how resources have been used and how people managed their wastes throughout history.

3 Read *The Patchwork Quilt*, by Valerie Flourney. Have students make a “recycled” patchwork quilt with each patch representing environmental information from one of the historical periods, or make one that includes all of the periods.

Directions for Making a Patchwork Quilt

MATERIALS

Assorted colors of stiff paper or card stock (old file folders); hole punch; yarn or colored string cut in 8” lengths; scissors; crayons or markers; pictures or drawings representing aspects of the historical period

DIRECTIONS

Cut the stiff paper into 6” squares. Paste a picture or drawing on each square. Lay out the card pictures in the sequence you want. Punch two holes in tops, bottoms and sides to join the squares.

Pull the yarn through the holes to join the squares; tie on the back. Hang on a bulletin board or wall, or display flat on a table.

Background Notes

NOTE: These notes are meant to be suggestions only. Language and concepts should be made age-appropriate. Add items and revise the list to help students answer questions on the handout, *You are the Expert*.

NATIVE AMERICAN CULTURE (in Ohio) – 1600-1800

- Waste is organic and biodegradable.
- Waste is burned, buried or left behind.
- Native people hunt and fish to provide basic needs.
- Population density is small.
- Native people make simple tools from wood and stone.
- Native people believe there are spirits in nature.
- Respect for environment; all life is sacred.

PIONEER CULTURE (in Ohio) – 1781-1840

- Most waste is organic and biodegradable.
- Pollutants include sawdust and chimney ash.
- Pigs are used to eat garbage.
- Fabric is made from sheep’s wool.
- People farm crops and hunt animals to provide basic needs.
- Crops are grown without pesticides and herbicides.
- People do not believe there are spirits in nature.
- Respectful of environment because of people’s dependence on their physical surroundings.

INDUSTRIAL CULTURE – 1840-1945

- Complex machines make products.
- Mining for coal and other minerals, and drilling for oil provides energy and materials to make products.
- Expansion of homes, factories and roads reduces farmland.
- Rapid growth of cities.
- More and more workers enter manufacturing and service occupations.
- Natural surroundings viewed as resources for unlimited use by man.

MODERN CULTURE – 1945-present

- Unregulated or abandoned hazardous waste facilities become a problem.
- Natural resources are processed into plastic and other synthetic materials.
- Litter is a problem.
- Non-point source pollution (run-off from fields, parking lots, etc.) is a problem.
- Urban waste is buried in sanitary landfills.
- Municipalities develop sewage treatment plants.
- Very few people are employed in agriculture as compared to those in industry and service occupations.
- There is some concern about the long-term effects of modern civilization on the environment.

Student Handout

YOU ARE THE EXPERT

Directions: Complete the following questions as directed by your teacher.

GROUP HISTORICAL CULTURE _____

EXPERT'S NAME _____

1 What did people do to make a living and provide for their wants and needs?

2 How were natural resources and the land used by this historical culture?

3 What types of things did people make and what types of tools or machines did they use to make these things?

4 What types of things did people throw away and what did they do with their waste?

5 What can be inferred about the relationship between these people and the environment?
How did these people change the environment (land, air, water, plants and animals)?

Student Handout

PRE- AND POST-TEST

- 1** List two items that might have been “thrown away” in Ohio by:

NATIVE AMERICANS 1. _____

2. _____

PIONEERS 1. _____

2. _____

A FAMILY IN 1910 1. _____

2. _____

A FAMILY TODAY 1. _____

2. _____

- 2** Explain how garbage and trash in our country have changed from early times to the present. What caused these changes? Use your answers from Question #1 as examples.

TRASH TIMELINE

- 500 BC** The first municipal dump in the western world was established in Athens, Greece. Waste had to be dumped at least one mile from the city walls.
- 1388** English Parliament banned waste disposal in public waterways and ditches.
- 1400** Garbage was piled so high outside Paris, France that it interfered with the city's defenses.
- 1690** The first paper mill in the United States was established near Philadelphia. The Rittenhouse Mill made paper from waste paper and old rags.
- 1757** Benjamin Franklin instituted the first municipal street cleaning service in the United States in Philadelphia.
- 1842** A report in England linked disease to filthy environmental conditions.
- 1850** Paper began being manufactured from wood.
- 1874** The first garbage incinerator went into operation in Nottingham, England. It was called "the destructor."
- 1885** The first incinerator in the United States was built on Governors Island in New York City.
- 1889** A Washington, D.C. health officer reports that "appropriate places for (refuse) are becoming scarcer year by year..."
- 1894** The first comprehensive system of public sector garbage management in the United States was started in New York City.
- 1896** Waste reduction plants that compressed organic wastes to extract grease, oils and other by-products were introduced to the United States from Vienna, Austria. (The plants were later closed because of their noxious emissions.)
- 1898** The first rubbish-sorting plant in the United States was organized in New York City.
- 1900** "Piggeries" were developed in small-to-medium-sized towns. Pigs were fed raw or cooked garbage.
- 1902** A Massachusetts Institute of Technology survey found that 79 percent of 161 U.S. cities provided regular collection of refuse.
- 1904** The first two major aluminum recycling plants opened in Chicago and Cleveland.
- 1904, 1906, 1916** The first modern landfills were opened in Champaign, Illinois; Dayton, Ohio; and Davenport, Iowa.
- 1916** Cities began switching from horse-drawn vehicles to motorized refuse collection equipment.
- 1920s** Using wetlands near cities became a popular landfilling disposal method. Landfill layers alternated garbage, ash and dirt.
- 1930s** Jean Vincenz, the public works commissioner in Fresno, California, coined the term "sanitary landfill."
- 1942-1945** During World War II, Americans collected rubber, paper, scrap metal, fats and tin cans to help the war effort.

Student Handout

TRASH TIMELINE, CONTINUED

Mid-1950s Public health departments prohibited the use of raw garbage in animal feed. 1965 The first federal solid waste management law, the Solid Waste Disposal Act, authorized research and provided state grants. 1970 The U.S. Environmental Protection Agency was created. The first Earth Day was celebrated on April 22. 1972 The first international environmental conference was held in Stockholm, Sweden. 1976 The U.S. Resource Conservation and Recovery Act (RCRA) created a significant role for the federal government in waste management. It emphasized recycling, conservation of energy and other resources, and launched the nation's hazardous waste management program. 1978 The U.S. Supreme Court ruled that states cannot ban shipments of waste from other states because garbage is protected by the Interstate Commerce Clause. 1979 The U.S. Environmental Protection Agency issued landfill criteria prohibiting open dumping.	1986 Fresh Kills Landfill on Staten Island, New York became the largest landfill in the world. It is 25 times larger than the Great Pyramid of Khufu in Giza, Egypt and 40 times larger than the Temple of the Sun in Mexico. Rhode Island enacted the nation's first statewide mandatory recycling law forcing citizens and businesses to separate recyclables from their trash. 1987 The infamous "garbage barge" from Islip, New York, was rejected by six states and three countries. The publicity drew public attention to the landfill capacity shortage in the Northeast. (The garbage was finally incinerated in Brooklyn, New York and the ash was landfilled near Islip.) 1988 House Bill 592 of the Ohio Legislature created solid waste districts, and recycling was added to community state grant programs. 1992 The "Earth Summit" was hosted by Brazil. The United Nations Conference on Environment and Development created Agenda 21, a blueprint for sustainable development in the 21st century.



Secrets in a Garbage Can

Objective

Students will be able to explain what discarded materials may reveal about a family or a society and their relationship to the environment.

Preparation

Decide how many groups you want to organize. Put three or more items from the Materials list into a container; each group should receive their own separate collection of items.

NOTE: This activity may be conducted using a single collection of items.

Procedure

1 Divide students into groups. Give each group a collection of trash items or make the items easily observable to the entire class. In their groups, have students discuss what each item reveals about the people who lived in the home that discarded the item. Responses can be recorded using the handout, *Stories Trash Can Tell*. Each student in each group can be responsible for a separate item.

For example, a steel vegetable can indicates a “need” for food and a desire, or “want,” to preserve the food item for a long time; the can is an example of technology (food preservation technology and steel fabrication); and in order to produce the can, natural resources (iron ore and coal) had to be taken (mined) from the environment. Mining may have affected the environment by

causing land, air and/or water pollution. The vegetable contents indicate a farming culture that probably cleared forest land in the past to plant crops.

2 Discuss group answers. Summarize what the class has learned about the family by looking at its trash. What do we know about them? What do we know about how they interact with their environment? Explore the meaning of the recycling symbol on the item(s) made from recycled material.

3 Also discuss the following: If we can learn “secrets” by looking at a family’s trash, what might we learn by looking at a community’s trash or trash from a society in the past?

4 **OPTIONAL:** Refer to the items used in Part B, #2 of the previous activity, *Everybody is an Expert*. Put these items in plastic tubs covered with dirt and have students “unearth” them, dusting them off with old paintbrushes. Students should examine each artifact, discuss it and analyze it by completing the chart, *Stories Trash Can Tell*, for each item. Point out that archaeology is basically a study of trash remaining from earlier civilizations. What do students think archaeologists in the future will learn about our society by looking in our landfills?

TRASH MAKES HISTORY

Inquiry

- What can be learned about people and societies, and their relationships to the environment, by analyzing trash?

Content Domain

Science – General science

Social Studies – Sociology, anthropology

Learning Outcomes

Science, Grade 4, #1, #14 and Grade 6, #3, #4

Duration

Two 50-minute class periods

Materials

For each group of students, obtain products that are discarded in the trash. The following is a sampling of recommended items: **lipstick tube, disposable diaper, screwdriver or paint brush, tooth brush, plastic bottle, glass bottle, aluminum or steel can, greeting card, newspaper, toaster or other old small electric appliance, pill container, small toy or other action figure**. In each group, try to include containers or packaging items that have the recycling symbol.

Handout

- *Stories Trash Can Tell*

Assessment

Have each student select an item (artifact) not previously discussed in class and complete the chart, *Stories Trash Can Tell*, for that item.

STORIES TRASH CAN TELL

1 Identify the trash item or “artifact” in the first column. In the other three columns, infer what the item can tell us about the people or society that generated this item in their trash.

ARTIFACT • What is the object? • Describe it, if you are not certain what it is.	SOCIETY • What want or need does this object appear to represent? • How might this object help satisfy that want or need?	TECHNOLOGY • How was the object made? • What types of tools or machines are necessary to make this object? • What type of energy is required to use the tools or machines?	ENVIRONMENT • What natural resources were taken from the environment to make this object? • How might the environment be affected or changed by making this object?

2 On the back of this page describe in paragraph form the people (culture) that generated this trash?



Throwaway Societies

Objectives

Students will be able to: (a) cooperate as a class to read and dramatize a historical review of waste disposal practices; (b) explain how societies of the past disposed of their wastes; and (c) identify the sequence of social evolution in Western culture.

Preparation

Make single-sided copies of the script for each student. Posters can be made and/or costume material can be brought in for students to use.

Procedure

1 Distribute scripts and assign parts: Narrator, Prehistoric Person, Cave Dweller, Roman, Briton, American Settler, American Colonist, four Industrialists, three Scientists, Native American and Chorus (as many in the chorus as needed so each student has a part).

2 Have each student make a poster to illustrate the content of his/her part. Chorus members should make the following posters: THROW IT, BURY IT, BURN IT TO ASH, REUSE, RECYCLING. (More than one poster of each can be used.) Narrator should make a poster of the title of the skit.

3 Students should fasten their scripts on the back of their posters and highlight or underline their lines.

4 Perform the skit with each student holding up his/her poster as they read the lines. Students should be arranged in speaking order, and all should stand at the beginning of the skit.

5 Follow the performance with a

discussion of how each culture disposed of their trash. Ask students why some societies have had more problems with trash than others (i.e. urban settings create problems of space for disposal). How might different disposal methods affect the environment? Are the three methods still being used today?

6 Scramble the six types of characters/societies (Prehistoric Society, Native American Society, Roman Society, Briton Society, Colonial American Society, Industrial Society) on the board and have students write the correct historical sequence of the societies without looking back at the script. If you have a classroom timeline, add these societies with a description of their solid waste practices, in the appropriate places.

Assessment

1 Choose six statements or passages from the script, one for each of the six societies. Read each of these (without telling students the name of the character/society of each) and have students identify which society made the statements.

2 Have students list each of the six cultures on a piece of paper and write an appropriate passage for each that could be added to the skit, reflecting some unique aspect about each culture.

TRASH MAKES HISTORY

Inquiry

- How have people disposed of waste throughout history?

Content Domain

Science – General science

Social Studies – History, sociology, anthropology

Learning Outcomes

Citizenship, Grade 4, #1 and Grade 6, #6

Science, Grade 4, #14

Duration

30-45 minutes, plus additional time for construction of set, costumes and designs if included

Materials

Optional: poster board, markers, crayons or paint, glue and/or transparent tape, costume items

Handout

- *Throwaway Societies* (script)

Extensions

1 After the skit is presented in the classroom, consider presenting the skit to another class, school assembly or PTO meeting.

2 Have students identify and describe where their waste is taken for disposal and/or recycling in the community by making drawings of major places in the community on a map and tracing the route their garbage takes on the map. Make similar maps based on inferences and any information that can be discovered about the local community during the 1920s, 1850s and the 1700s (by Native Americans and early settlers).

Student Handout

THROW-AWAY SOCIETIES

Adapted from *A-Way With Waste*, Washington State Department of Ecology.

NARRATOR (1)

This is the tale of the Throwaway Three,
Of man and his garbage throughout his-to-ry.
Now they're very nice people, just like you and me
Who all have a problem, as you will soon see:
What shall they do with their garbage and trash?

CHORUS (2)

Why, throw it! Or bury it! Or burn it to ash!

PREHISTORIC PERSON (3)

I represent people when we lived very free.
I get rid of garbage so easily!
It's a snap! It's no problem! It's tossed on the ground,
And when things get smelly, we just move around!

CAVE DWELLER (4)

I am a cave dweller; I use all I see.
What I do with old stuff is all up to me.
I burn it, like meat, burn it up in the fire
Or bury it, like bones, in the muck and the mire.

CHORUS (5)

Yes, throw it, or bury it, or burn it to ash!
That's how we always get rid of our trash!

ROMAN (6)

I am a Roman who lives in a town;
New laws won't allow me to just throw trash down.
I am required to take it a full mile away
Before I can dump it. This happens each day!

BRITON (7)

I am a Briton, wary and quick;
Down on my street, trash gets pretty thick.
When housewives upstairs want to pitch out their goo,
Out the window it goes as they yell: "Gardy-loo!"
The garbage will stay there until the next rain,
Or until our fair London should burn down again.

CHORUS (8)

Oh, what do we do with our garbage and trash?
We throw it, or bury it, or burn it to ash!

SETTLER (9)

I am a settler. I came without much:
Only my tools, my clothing and such.
Everything else I must make all by hand;
So I don't throw out much – I use all I can.
Cloth scraps become quilts; I reuse my bent nails.
It will be a long time 'fore the next trade ship sails.

COLONIST (10)

I am a colonist. Now, life's not so tough.
We have trade between cities that brings lots of stuff,
And some things are made by our townsfolk. Today
I could buy a new harness, throw this one away.
We have pigs and hogs running loose in our street;
If I toss garbage out there, they'll eat it up neat.
Or I might bury it right over there –
Or I might burn it. Nobody would care.
You see, the New World is the same as the Old!
We trashmakers come from a time-honored mold.

THROW-AWAY SOCIETIES PAGE 2

CHORUS (11)

What are we still doing with garbage and trash?
You guessed it! Throw it, or bury it, or burn it to ash!

INDUSTRIALIST #1 (12)

I'm the industrial person, new on the scene;
I mass produce goods with my trusty machine.
This sweater, handmade, took a week years before,
But now, in one hour, I can make forty-four.
I make things so cheaply, you can now afford two,
And discard twice as much trash as you need to do.

SCIENTIST #1 (13)

I am a scientist in the new post-war age.
We learned a few tricks while war shortages raged.
When we couldn't get natural stuff to process,
We invented synthetics to replace them. Oh, yes!

INDUSTRIALIST #2 (14)

Your old woolens and silks, leather and cotton,
Wooden toys and washboards will all be forgotten.
We'll use rayon and nylon, acrylics and plastic
To make furniture, clothing and even elastic.

SCIENTIST #2 (15)

Our new stuff will last 'til forever, you see
Even when it's worn out to you and to me.
Permanent pressed, pre-sized and pre-shrunk,
When dingy and old, it's permanent "junk!"

INDUSTRIALIST #3 (16)

We make instant menus that come in a pack;
You just boil the food in its own plastic sack.
And our TV dinner in its disposable tray –
It's quick! You don't wash it, just throw it away!

SCIENTIST #3 (17)

We make lots of TVs and clothes dryers, too.
Don't ask for a trade-in, you're kidding, aren't you?

INDUSTRIALIST #4 (18)

Each year, new cars have a different design;
So repairs will be costly to yours and to mine.
Soon we won't bother to make last year's parts
For Skylarks, Novas, Cougars and Darts.

SCIENTIST #5 (19)

It's the new gadget, the new style that Americans crave;
So out with the old stuff! Away to a grave!

INDUSTRIALIST #5 (20)

So what, if more of us are buying more goods?
So what, if they won't rot away as they should?

NATIVE AMERICAN (21)

Now wait just a minute! You cannot fail
To include me in your historic trash tale!
We Indians lived simply, on prairies, in woods,
We made no high trash piles, nor mass-produced goods.
Let me be your critic, show you just where you stand,
And how you're defiling our wonderful land.
Your newfangled goods will not rot away -
When you throw them down, they remain where they lay.
You say you will bury them deep in the ground,
The trash from your cities will make quite a mound!
And sometimes you burn things in smoldering masses
That fill up the air with hot, deadly gases!
Oh, all of your answers have faults everywhere:
And pollute the water, the land or the air.
What's more, your resources - your oil and your ore
Get smaller each year...and Earth's not making more!

INDUSTRIALIST #6 (22)**THROW-AWAY SOCIETIES****PAGE 3**

You're right. Our resources are shrinking away
While our throwaway problems grow bigger each day.
We convert our resources to wants, wishes and needs;
When reuse and recycling should be our new creeds.

SCIENTIST #6 (23)

Oh, stop it! Don't drop it! We'll think of a way
To make food for cows that's better than hay.
Don't burn it! Return it! We'll make something new:
A vase for your mother, a new hat for you.
Don't bury it. Carry it back to the mill;
We'll make a new blanket to ward off the chill.

CHORUS (24)

Yes, it's time we progressed past the Disposal Age
To make reuse and recycling the popular rage!
We'll have to give up old solutions for trash
And realize its pure balderdash - to just
Throw it, or bury it, or burn it to ash!

NARRATOR (25)

This was the tale of the Throwaway Three,
Of man and his garbage throughout history.
We hope that you've learned a lesson from us
And will change waste disposal without any fuss.
Don't throw it, or bury it, or burn it outside;
Reuse and recycle, it will fill you with pride.



JOURNEY OF A GARBAGE BILL

Environmental Studies Learning Concept

How land and resources are used is a function of laws, customs and practices governing the rights, duties and relationships of people to the land. Land is both a public and private commodity with economic value related to commercial actions. Resources, in the form of natural resources and finished goods, have economic value related to commercial actions.

Governments can regulate industry and commerce to serve the public interest. Environmental legislation frequently involves conflicts between public and private business interests and between local, state and federal governments.

Solid waste management is a local community concern that has progressively been regulated by state and federal governments through legislation. As an aspect of solid waste management, recycling may be enhanced or hindered by economic market conditions and by local, state and national laws, regulations, ordinances and policies.

Vocabulary

General Assembly – a body of legislators; in Ohio this body, which is also called the state legislature, includes members of the House of Representatives and the Senate

governor – the most important person in the executive branch of state government; responsible for administering and enforcing the laws of the state

House Bill 592 – an Ohio law that provides rules and regulations for managing everyone's garbage or solid waste

House of Representatives – one of two groups or chambers that make up the Ohio Legislature or Ohio General Assembly; its 99 members propose and make laws

Senate – one of two groups or chambers that make up the Ohio Legislature or Ohio General Assembly; its 33 members propose and make laws

solid waste – garbage and trash from residences, businesses and institutions (schools, hospitals, etc.)

solid waste management districts – districts made up of one or more county governments in Ohio for the purpose of complying with the statutes of House Bill 592, Ohio's solid waste management law

standing committee – a group of state legislators, within the House of Representatives and the Senate, who are assigned to consider a specific public concern, such as agriculture, education, transportation and the environment; they hold public hearings on bills, debate them and revise them

Overview – JOURNEY OF A GARBAGE BILL



Activity 1: Journey of a Garbage Bill

Description

Students *write* entries in a journal detailing the legislative process, using a solid waste management bill as an example. A role-playing exercise reenacts the process of how a bill becomes a law through the testimony of citizens, public officials and experts. Students *listen* carefully to *make inferences* from the testimony read by other students in order to define important terms, summarize the major idea of each passage and distinguish fact from opinion. At the end of each round, students *develop group discussion skills* to *make decisions* about which provisions, based on testimony, should be included in the bill. After the exercise, they discuss the roles of state and local governments and how citizens and local and state governments must cooperate to solve problems and make choices.

Ohio Proficiency Test Learning Outcomes

Grade 4, Citizenship #13 – Identify the function of each branch of state government.

Grade 4, Citizenship #14 – Identify the purposes of state government.

Grade 4, Citizenship #15 – Identify or explain the purposes of local government.

Grade 4, Citizenship #16 – Differentiate between statements of fact and opinion found in information about public issues and policies.

Grade 4, Citizenship #17 – Identify and assess the possibilities of group decision making, cooperative activity and personal involvement in the community (e.g., vandalism, school rules and recycling).

Grade 6, Citizenship #17 – Interpret how examples of political activity illustrate characteristics of American democracy.

Grade 6, Citizenship #19 – Analyze information on civic issues by organizing key ideas with their supporting facts.

Grade 6, Citizenship #20 – Identify and analyze alternatives through which civic goals can be achieved and select an appropriate alternative based upon a set of criteria (e.g., fire hydrant repair, use of public buildings, recycling programs).

Summary

This lesson consists of one activity.

Background Information

Garbage issues are often more complex than they first appear. As solid waste management issues became more complex during the past decade, local, state and federal governments have intervened. Ohio **House Bill 592 (H.B. 592)**, passed in 1988, is an example of how state government intervened locally to deal with solid waste management problems. H.B. 592 reflects the intentions of local and state governments to provide public services while protecting the health and safety of citizens. Implementing H.B. 592 has required cooperation among citizens, businesses and local and state governments.

The legislative branch of government in Ohio, referred to as the **General Assembly**, is made up of two houses – the **House of Representatives** with 99 members, and the **Senate** with 33 members. It is the responsibility of the General Assembly, as with any legislative branch of government, to write laws. A proposed new law is called a **bill** until it is approved by a majority in both houses.

Once introduced, a bill is reviewed and assigned to a **standing committee**. Standing committees are extremely important in the process of passing laws. These committees debate, refine and rewrite the bill and hold public hearings throughout the state when needed. Although the number and titles of standing committees may vary in each house, both houses generally have ongoing committees that focus on important issues, such as agriculture, health and human services, the environment and education.

Once passed the bill is referred to as an act. The act then goes to the **governor** who may sign it into law, allow it to become law without his

signature, or veto it. If the governor vetoes an act, it is possible for the General Assembly to override the veto by obtaining a three-fifths vote of approval in each house.

H.B. 592 was developed because of concerns about out-of-state waste coming into Ohio for disposal. By the time it became law, it included numerous statutes and established **solid waste management districts (SWMDs)** at the county government level. H.B. 592 requires the Ohio Environmental Protection Agency and local SWMDs to develop and implement a solid waste management plan that meets the mandates of H.B. 592. These mandates include:

- Reduce reliance on landfills by reducing the amount of waste generated and by reusing, composting and recycling waste materials.
- Promote markets for recycled materials so there will be an economic incentive to recycle.
- Improve landfill construction and management so the potential for pollution is reduced and the environment and public health are protected (through the application of technology to prevent ground water contamination, surface water runoff and explosions of methane gas).
- Restrict the dumping of some hazardous waste materials, such as batteries and industrial process wastes.
- Establish a program for the proper separation and disposal of hazardous waste generated by households.
- Plan for future disposal needs.

H.B. 592 could not resolve the original concerns about the exporting of waste into the state from other states. That issue remains disputed, although the U.S. Supreme Court

recently ruled that it is a violation of interstate commerce to restrict the flow of solid waste. States cannot impose excess fees on incoming waste, and they cannot outlaw the exportation of solid waste. Controlling the flow of solid waste is also a local issue within solid waste management districts and has led to disputes between businesses and local governments over restricting the flow of waste within and between Ohio counties. Therefore, solid waste issues have involved all three branches of government: legislative, executive and judicial branches.

Bibliography and Additional Resources

Student Resources

The Environmental Crisis: Opposing Viewpoints, edited by Neal Bernards, Greenhaven Press, Inc., 1991.

Garbage, by Karen O'Connor, Lucent Books, Inc., 1989.

Recycling, by Don Nardo, San Diego: Lucent Books, Inc., 1992.

Recycling, by Rebecca Steffoff, New York: Chelsea House Publishers, 1991.

Educator Information

State Solid Waste Management Plan, Columbus, Ohio: Ohio Environmental Protection Agency, 1995.

The Ohio Almanac: An Encyclopedia of Indispensable Information About the Buckeye Universe, edited by Michael O'Bryant, Orange Frazer Press, 1997.



Journey of a Garbage Bill

Objectives

Students will be able to: (a) make inferences from written and oral information about the organization and purposes of local and state governments; (b) explain how a bill becomes a law; and (c) identify controversial issues in solid waste management.

Preparation

Cut out the speaking roles from the handout, *The Story of a Bill: Classroom Roles*. Keep a complete copy to follow along with as students read the individual passages. Before the class activity, review the testimony passages to acquire an understanding of the roles.

Procedure

1 Have students prepare a journal for the role-playing exercise. On the cover of their journals, have students write the title “Journey of a Bill” and their names. Tell students they will find out what a “bill” is when conducting the exercise.

2 Show students a bag of trash and explore briefly what its contents might include. Mention that it seems like such a simple thing – “just a bag of trash.” Ask students: Who decides what happens to this bag of trash? Families decide who should take the garbage out to the curb, but who decides what hap-

pens to it once it is at the curb? Explain to students that the role-playing activity will try to answer the question: Who decides what happens to this bag of trash?

3 Have students write on the first page of their journal the following question: Who decides what happens to a bag of trash? Have them make a list of answers based on the class discussion in Step 2. This can be used as a pre-assessment by comparing their initial answers with their answers to this same question at the end of the journal. Or, you may pre-assess students’ understanding of laws and lawmaking, in the context of solid waste management, by using the model tests described in the Assessment section. If students already have a basic understanding of the structure of government and laws, skip Step 4 and proceed to Step 5.

4 Ask students to define “government.” Ask them to define a “law.” Discuss these two concepts briefly. (In general, government makes rules, or

Inquiries

- What is the nature of state and local governments in Ohio?
- What is the role of state and local governments in solid waste management?
- How does a bill become a law in Ohio?

Content Domain

Social Studies – Government, civics

Learning Outcomes

Citizenship, Grade 4, #13, #14, #15, #16, #17 and Grade 6, #17, #19, #20

Duration

Four to five 50-minute class periods

Materials

Writing and drawing materials, notebook or notebook paper for making a journal (about 20 pages)

Handouts

- *The Story of a Bill: Classroom Roles*
- *Words of Citizenship*
- *A Bill*
- *Decisions, Decisions*

laws, to live by and provides services that people need and/or want, such as police protection, garbage collection, etc.)

Using a pencil, have students construct a model of “circles of government” on a page in their journal. Have them draw a small circle in the middle of the page and write the word “house” in the circle. Briefly discuss some rules and services that exist in households, then have students draw another circle around the house circle and label it “school.” Briefly discuss some rules and services that exist in schools. Identify what type of local government exists in the community for the next ring or rings. (This could be one or more rings to designate township board of trustees and/or city, village or town council, and/or board of county commissioners.) Briefly explore what types of rules and services local governments provide. Next, have students add a ring for state government, followed by a ring for the federal (U.S.) government. Briefly explore what type of rules (laws at this level of government) are made by state and federal governments.

5 Engage students in the role-reading exercise from the handout, *The Story of a Bill: Classroom Roles*. These roles portray how Ohio’s solid waste bill, H.B. 592, became a law. It includes 20 passages of testimony to be read in sequence by different students.

NOTE: The passages of testimony are not from any specific testimony actually presented in the making of H. B. 592, but they summarize many of the concerns discussed and debated.

The exercise is to be conducted in three separate parts. These parts are: PART A: A county in Ohio; PART B: The Ohio House of Representatives in Columbus; and PART C: The Senate Chamber in Columbus. Before you

begin each part, have students write these headings in their journals.

Students who are not reading passages of testimony are to role-play the following for each part.

Part A: writers who draft H.B. 592 for the sponsor of the bill in the House of Representatives.

Part B: Members of the House of Representatives’ standing committee debating and rewriting the bill.

Part C: Members of the Senate’s standing committee debating and rewriting the bill.

Part D consists of one passage only. There is no follow up to Part D.

After each passage of testimony is read, review the passage and clarify complex issues. Then, have all students record the following in their journals:

(a) **important terms** – In the passages, vocabulary words are listed in bold. When a passage contains a highlighted word, have the student who read the passage write the word(s) on the board. (Some passages do not contain any highlighted vocabulary words.) Discuss the meaning of the vocabulary words based on making inferences from the passage. Have students record these inferred definitions in their journals. The teacher page, *Words of Citizenship*, contains definitions for all of the highlighted words in the passages.

NOTE: As the exercise continues, passages may reveal additional information about previously identified vocabulary words. This new information should be added to each vocabulary word; therefore, have students write the meanings of vocabulary words in pencil and leave several spaces below each definition to make changes.

(b) **main idea of the passage** – Discuss this as a class and then have

students write in their journals a sentence that describes the main idea of the passage.

(c) **facts** – Discuss and have students write facts from the passage in their journals.

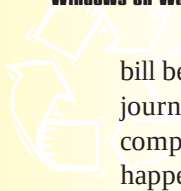
(d) **opinions** – Discuss and have students write opinions from the passage in their journals.

6 As each of the three parts is completed, have students meet in groups to write proposals for the bill on the handout, *A Bill*. Discuss each group’s proposals and how well they expressed the “main ideas” of the testimony (numbered passages).

Write a single classroom H.B. 592 based on the discussion and have a student record these proposals on a blank copy of the handout, *A Bill*. Students should record a summary of this classroom version of the bill in their journal before proceeding to the next part. Students who speak at the beginning of parts B, C and D will read the classroom versions of H.B. 592.

NOTE: On the handout, *A Bill*, the format at the top of the page resembles what a real bill looks like when passed by legislators. The space indicated “as proposed” should be checked when preparing the initial bill in Part A; the space indicated “as passed by the House of Representatives” should be checked when rewriting the bill at the end of Part B; the space indicated “as passed by the Senate” should be checked when rewriting the bill at the end of Part C.

7 After the governor reads the final passage, have students reconsider the question: Who decides what happens to this bag of trash? (Ultimately it is the people or citizens who either become actively involved or who participate through the government representatives they vote for.) Have them draw and label a diagram about how a



bill becomes a law at the end of the journal. Discuss with students the complexities of trying to decide what happens to a bag of trash.

8 Compare the classroom H.B. 592 with provisions of the real H.B. 592 as described in the background information to this lesson.

9 Review other aspects of the exercise.

(a) Explore the role of the various branches of government in the exercise. Make a list of words that are related. For example, the words “legislative branch,” “Ohio General Assembly,” “legislation,” “Ohio House of Representatives,” and “Ohio Senate” are related because they all represent the legislative branch of government. Words such as “court” and “judge” refer to the judicial branch of government. Words such as

“state agency” and “governor” refer to the executive branch of government.

(b) Explore facts and opinions and how they may help or hinder a decision-making process.

(c) Discuss the roles of state and local governments.

(d) Discuss how citizens and local and state governments must cooperate to solve solid waste problems and explore alternatives.

10 Review aspects of the exercise that are examples of democracy in action.

Assessment

1 Review student summaries at the end of their journals about how a law is passed.

2 Give students the handout test, *Decisions, Decisions*, to complete.

ANSWERS: 1. b, 2. d, 3. a, 4. b, 5. b, 6. c

The last two questions require a rubric grading scheme.

Extension

Have students identify a solid waste or litter problem in their community. Have them write to a local official and/or state representative to share the problem and possibly offer some suggestions for solving the problem.

Student Handout

THE STORY OF A BILL: CLASSROOM ROLES

PART A: (A county in Ohio, 1987)

.....

1 My name is Mr./Ms. _____. I am a concerned **citizen**. I have lived in Ohio all my life. I belong to a **public interest group** called Save the Land. We have 800 members in Ohio and we think there is a garbage problem. People in New Jersey, New York and other states in the East are dumping a lot of their trash in **landfills** in my county. Did you know that many of the landfills in Ohio are closing because they are too full? It's not easy finding places to build new landfills. We need the **government** to do something. We should not allow **out-of-state waste** in Ohio, if we are running out of space to bury our own trash.

.....

2 My name is Mr./Ms. _____. I am part of **local government**. I am a county commissioner, elected by the people of my county to the **county government**. Our old landfill will be full in one year. Many people in my county are worried about where we will build the next landfill when our old one fills up. Our landfill is filling up faster because it accepts garbage from other counties in Ohio and from other states.

.....

3 My name is Mr./Ms. _____. I am a **state government** representative in the **Ohio House of Representatives** in the **General Assembly** in Columbus. There are 99 of us in the House, representing districts that include all of the people of Ohio. In my district, many people are concerned about the garbage problem. Because the people in my district voted me into office to represent their interests, I will propose a **bill** to deal with the **solid waste** problem. This bill will be called **House Bill 592**, or just H.B. 592. This bill has to be accepted by the General Assembly in order to become a **law**. This is because the General Assembly is the **legislative branch** of government in Ohio.

.....

PART B: House Bill 592 “as proposed”

Directions: Have students work in groups to write proposals on the handout, *A Bill*. Check the space marked “as proposed.” Discuss these group proposals and write a single classroom bill to be given to the first speaker (#4) in Part B.

THE STORY OF A BILL: CLASSROOM ROLES, CONTINUED

PART B: (The Ohio House of Representatives in Columbus)

.....

4 My name is Mr./Ms. _____. I am a state representative in the Ohio House of Representatives and the chairman of a **standing committee** in the House, called the House Energy and Environment Committee. There are many standing committees in the House, each one deals with a different subject, such as education or the environment. The House Energy and Environment Committee considers problems and issues about our environment in Ohio. Since garbage is an environmental problem, the House Energy and Environment Committee will examine and discuss House Bill 592. Then we'll hold **public hearings**. People from all over the state will have a chance to tell us what they think about the new bill. First I will read what House Bill 592 says. (Read classroom H.B. 592 as proposed in Part A.) Now let us hear what other people have to say about this bill.

.....

5 My name is Mr./Ms. _____. I own and operate a landfill and I make money when people and trash haulers bring garbage to me. This is because I charge them a tipping fee to dump their garbage in my landfill. Right now, I charge \$26 a ton. If trash haulers cannot bring me a lot of garbage, including trash from out-of-state, I will lose money. So, I do not think we should restrict the flow of waste. I should be able to accept garbage from anyone and from anywhere.

.....

6 My name is Mr./Ms. _____. I am a waste hauler and a business person. I collect garbage from many different places including Pennsylvania and New Jersey. I feel I should be able to take garbage to the landfill that is the cheapest for me. If a landfill operator charges me \$50 a ton in Pennsylvania to dump my garbage and one in Ohio charges only \$25 a ton, then I would rather go to the landfill in Ohio. By the way, did you know that garbage from some Ohio communities is taken to landfills in Kentucky and Michigan?

.....

7 My name is Dr. _____. I am a doctor and a member of a public interest group called Our Health First. We are concerned about having enough landfill space, but we think **health and safety** issues are important too. Many of Ohio's old landfills were shut down by local governments because of the pollution they created. Over the years, all types of garbage have been dumped in local landfills; some of it is hazardous waste, such as batteries, motor oil and chemicals from factories and businesses. Did you know that chemicals from buried trash can seep into the ground water or into rivers and lakes? Those are all sources of drinking water. Also, some local landfills have caught on fire from methane gas that builds up inside them. It is very important that public health is protected by this bill!

.....

8 My name is Mr./Ms. _____. I am a civil engineer. You should know that we can build landfills so they are safe. Today's new landfills are designed to prevent fires and to prevent pollution. We do this by making landfills with liner systems that keep liquids from leaking into ground water. We engineers can also build vents to release or capture methane gas so it does not collect and become dangerous.

THE STORY OF A BILL: CLASSROOM ROLES, CONTINUED

.....

9 My name is Mr./Ms. _____. I am a city council member in my local **municipal government**. Our town has a **recycling** program that will make our landfill last longer. We save landfill space by recycling newspaper, cans and bottles, and by composting our food and yard waste. Sometimes we can make money by selling our recyclables. But, when the market is not good for recyclables, we don't make enough money to pay for the cost of collecting them. However, the townspeople pay a small fee to have their recyclables collected. This helps us pay for the recycling program, even when markets are not good. Our residents know that recycling helps the environment in many ways. We know recycling saves landfill space. But did you know that recycling also saves energy and resources when businesses use recycled materials to make new products? Recycling also reduces pollution by slowing down the need to mine or drill for natural resources. So, my city council knows that recycling collection is **public service**, which is also good for the environment.

.....

10 My name is Mr./Ms. _____. I am a member of this standing committee. I think we need to consider what everyone has said about this bill and change it. There are many difficult issues to think about as we revise this bill before presenting it to the full House to vote on. Then, if approved by our House members, this bill will be sent to the Senate for further consideration.

.....

PART B: House Bill 592 “as passed by the House of Representatives”

Directions: What revisions should be made to H.B. 592? What new provisions should be added and should any original ones be changed or deleted? Repeat the same procedure used at the end of Part A. This time, check the space marked “as passed by the House of Representatives” on the handout, *A Bill*, and give the classroom bill to the first speaker (#11) in Part C.

PART C: (The Senate chamber in Columbus)

.....

11 My name is Mr./Ms. _____. I am a State Senator. The **Ohio Senate**, like the Ohio House of Representatives, is also part of the Ohio General Assembly. There are only 33 of us, but we also represent districts that include all of the people in Ohio. We also have standing committees that hold public hearings about **legislation**. We will now discuss House Bill 592 in our standing committee called the Senate Energy, Natural Resources and Environment Committee. I am the chairman of this standing committee. House Bill 592 has been changed or amended by the House. Here is what amended House Bill 592 says. (Read the bill as revised in Part B by the House of Representatives.) Now let us discuss this bill and hear more opinions.

.....

THE STORY OF A BILL: CLASSROOM ROLES, CONTINUED

12 My name is Mr./Ms. _____. I am a proud member of this **state legislature**, but I want you to know that I am also concerned about local governments. This piece of legislation may have so many rules and regulations that local governments will lose control over how to manage their own solid waste. I hope local governments will be free to decide what they want to do with their garbage. I hope the state government is not going to tell local governments what they must do. Every local government situation is different. Some have good recycling programs while others don't have any at all. Some communities have landfills that pollute and others have built new landfills that don't pollute. We should not tell local governments with good programs what to do.

.....

13 My name is Mr./Ms. _____. I am a member of the Ohio Chamber of Commerce, which represents businesses in Ohio. We do not want government making a lot of rules that will hurt businesses, such as trash haulers and landfill operators. Some counties in Ohio want to build large recycling facilities and require the trash haulers to bring all the garbage they collect to the recycling facility. This will help the county pay for the recycling facility because they will charge the trash haulers a tipping fee to dump their garbage at the recycling facility, just like at a landfill. But what if the trash haulers can pay less to dump their waste at a landfill in another county? This means they will have to pay more to dump their garbage at the recycling facility. This is not fair. As a business, they need to haul the garbage they collect and dump it where it is the least expensive, so they can make a profit.

.....

14 My name is Mr./Ms. _____. I am a concerned citizen. I want you to know that we make too much waste. We need to recycle and reuse more, before throwing our waste away. What is the most important issue here? Should we just look at the cheapest way of getting rid of our garbage? I don't think so. We should consider doing something that is good for the environment, even if it means paying more. A lot of people support recycling because it is good for the environment. In fact, I have a survey that says 80 percent of all Ohioans say they are concerned about the environment and would pay more to protect the environment.

.....

15 My name is Mr./Ms. _____. I am a township trustee in my local **township government**. I think many of us in local governments across Ohio are worried that if the State regulates how to build landfills and requires recycling and other programs, there won't be enough money to run the new programs. No one has talked about raising state taxes to pay for the proposals in this legislation. People may say they will pay more to protect the environment, but no one wants to pay more taxes.

.....

16 My name is Mr./Ms. _____. I am a senator who is concerned that our bill may include provisions that conflict with laws already in place, especially laws related to the United States **constitution**. I think we need to hear from someone in the **judicial branch** of state government to give us some advice.

.....

THE STORY OF A BILL: CLASSROOM ROLES, CONTINUED

17 My name is Mr./Ms. _____. I am a **judge** in a state **court**. We often interpret laws when people or groups disagree with a law. I think if you make a law restricting out-of-state waste, you may be in conflict with the United States constitution. The constitution says that no state shall prohibit **commerce** between states. Waste hauling is a form of commerce because people are buying and selling a service to get rid of trash. This same rule may apply to the other issue raised by the Chamber of Commerce person. Some county governments may want to make all of the trash haulers within the county dump their waste at a recycling center or landfill in the county to make enough money to operate the facility. If a trash hauler cannot choose where to take his/her trash, that may also be a form of restricting commerce. This issue may have to be settled at local county courts, state courts or even federal courts, depending upon the dispute.

.....

18 My name is Mr./Ms. _____. I work for the **Ohio Environmental Protection Agency**, also called the Ohio EPA. As part of the **executive branch** of the state government, our **public agency** is responsible for carrying out laws that protect the environment. We also collect information about the environment. Many counties in Ohio will run out of landfill space in the future. It is also true that some older landfills in Ohio are generating pollution. Many of the proposals in this bill will be sent to us to carry out and enforce. We await your decisions.

.....

19 My name is Mr./Ms. _____. As a member of this Senate committee, I think we need to consider what everyone has said about this bill and revise it again. There are many difficult issues to think about before we present it to the full Senate to vote on. Then, if passed by the Senate, this bill will be sent to the governor for approval.

.....

PART C: House Bill 592 “as passed by the Senate”

Directions: How should H.B. 592 be revised? Repeat the same procedure used at the end of Part A. This time, check the space marked “as passed by the Senate” on the handout, *A Bill*, and give the classroom bill to the next speaker (#20) in Part D.

PART D: (The governor’s office)

.....

20 My name is Mr./Ms. _____. I am the **governor** of Ohio and the leader of the executive branch of state government. The General Assembly has given me House Bill 592 to review. Here is what it says. (Read the bill as revised in Part C by the Senate.) If I do not like this bill, I do not have to sign it and it can still become law. If I really do not like the bill, I can veto it. If I veto it, it must go back to the General Assembly. If they pass the bill a second time, it will become a law, even if I do not agree with it. However, I like this bill and so I will sign it into law. (Sign the page at the bottom.) House Bill 592 is now a law. It represents **democracy** in action because many voices were heard and compromises were made. This law, even if it’s not perfect, can help us deal with our garbage problems. Citizens and local and state governments will still have to cooperate to make this law work. And as we all know, the law can be changed in the future, if the people want it to be changed.

WORDS OF CITIZENSHIP

bill – a proposal to make a law; a bill becomes a state law in Ohio when it is accepted (passed) by both chambers (House of Representatives and Senate) of the Ohio General Assembly

citizen – a person in a community who can affect what government does by voting and civic action

commerce – the buying and selling of goods and services

constitution – a plan or framework for government that establishes branches of government (legislative, executive, judicial), their duties and the fundamental laws and principles of government

county government – a local form of government that is run by the board of county commissioners; it makes ordinances and provides public services to comply with state and federal regulations, laws and mandates; each Ohioan lives in one of the state's 88 counties

democracy – a form of government that provides a way for citizens to vote and take civic actions that determine what local, state and national governments do; citizens are the source of all authority

executive branch – one of three branches of government; in Ohio it includes the governor and agencies that administer and enforce state and federal laws

General Assembly – a body of legislators; in Ohio this body, also called the state legislature, includes members of the House of Representatives and the Senate

government – a group of people and agencies that make laws, resolve conflicts and provide services that people want and need

governor – the most important person in the executive branch of state government; responsible for administering and enforcing the laws of the state

health and safety – provided by governments in the form of laws, ordinances and public services that make life safer for people (e.g., food inspection, pollution laws, fire and police protection)

House Bill 592 (H.B. 592) – an Ohio law that provides rules and regulations for managing garbage or solid waste in the state

judge – an elected or appointed official who makes decisions in courts of law

judicial branch – one of three branches of government; responsible for resolving conflicts between people and groups and for interpreting the law

court – a place where conflicts between people and groups can be resolved with the aid of a judge or judges

landfill – a place where garbage and trash are buried and covered with soil; may include pollution control technology

law – a bill that was passed by a majority vote by members in both houses or chambers of the Ohio General Assembly, and may or may not be signed by the governor; it contains rules about human activity that may be enforced by authority or expected to be generally observed in the interest of order

legislation – laws or the process of making laws

legislative branch – one of three branches of government that is in charge of making laws; in Ohio it is called the General Assembly

local government – makes rules and ordinances, provides systems of justice, and makes provisions for various public services through county, municipal and township forms of government

municipal government – a local form of government for cities and villages run by a mayor and city or village council members to provide public services for people and to make local ordinances

Ohio Environmental Protection Agency (Ohio EPA) – a state agency that is part of the executive branch of government that administers and enforces laws designed to protect the environment

Ohio House of Representatives – one of two groups or chambers that make up the Ohio Legislature or Ohio General Assembly; its 99 members propose and make laws

Ohio Senate – one of two groups or chambers that make up the Ohio Legislature or Ohio General Assembly; its 33 members propose and make laws

continued next page

WORDS OF CITIZENSHIP, CONTINUED

out-of-state waste – solid waste that is transported from one state to another for disposal

public agency – a group of people who work to help governments enforce laws, provide services and resolve conflicts

public hearing – an event sponsored by the legislature or public agency to hear what people have to say about a particular issue

public interest group – a group of citizens who are concerned about a problem and try to persuade lawmakers and others to take action to solve the problem

public service – something that is done by local and state governments that provides a service people want or need, often through the collection of taxes (e.g., police and fire protection, libraries, courts of law, food stamps)

recycling – a method of reducing the amount of solid waste that must be disposed of and a process for collecting and sorting waste materials so they may be reused in manufacturing processes

solid waste – garbage and trash from residences, businesses and institutions (schools, hospitals, etc.)

standing committee – a group of state legislators who are assigned to consider a specific public concern such as agriculture, education, transportation, the environment; they hold public hearings on bills, debate them and revise them; each chamber, the House of Representatives and the Senate, has its own separate committees

state government – composed of three parts or branches: legislative, executive and judicial

state legislature – made up of a group of people called legislators who make laws based on the wants and needs of people; in Ohio it is composed of two houses or chambers, the House of Representatives and the Senate

township government – a form of local government not incorporated as municipalities that represent subdivisions of counties; it is run by a board of trustees who provide public services for people

Student Handout

A BILL

117th General Assembly
Regular Session
1987-1988

House Bill 592

_____ as proposed
_____ as passed by the House of Representatives
_____ as passed by the Senate

LIST OF PROPOSALS:

Student Handout

DECISIONS, DECISIONS

Directions: For numbers 1 – 6, place the letter of the correct answer in the space provided.

- _____ 1 If a law is made that requires every community in Ohio to recycle 35 percent of their waste, who would make this law?
- a. the local government
 - b. the state legislative branch of government
 - c. the state executive branch of government
 - d. the state judicial branch of government
- _____ 2 A local community has decided to start a recycling program. As part of this program, each family is asked to separate recyclable materials from the rest of the garbage and place them in a separate container. The family puts the container at the curb for pick up once a week by the local government collection service. This is an example of:
- a. families taking care of their waste by themselves
 - b. community cooperation with local government to make streets cleaner and dump more trash in the local landfill
 - c. state government making a law to reduce waste disposal and save resources
 - d. community cooperation with local government to reduce waste disposal and save resources
- _____ 3 Why does the Ohio government make laws about how landfills must be constructed and maintained?
- a. to protect the health and safety of citizens
 - b. to protect people's right to live where they want
 - c. to provide a public service for the collection of garbage
 - d. to make money selling landfill designs
- _____ 4 Which of the following statements is an opinion?
- a. Many communities have recycling programs in Ohio.
 - b. There should be more recycling programs in Ohio.
 - c. Forty percent of all landfills will close in five years.
 - d. Cincinnati has a large landfill.

DECISIONS, DECISIONS, CONTINUED

- _____ **5** When the Ohio General Assembly passed House Bill 592, this was an example of:
- citizens voting on a law that protects them
 - citizens making a law by voting for representatives in the legislature
 - citizens making a law by voting for judges in state government
 - local government in action
- _____ **6** Deciding what to do with garbage is more complex than people think. Some local community groups believe they should have the right to forbid waste haulers from bringing out-of-state trash into their community landfill. That way, the landfill will not fill up so fast. On the other hand, some landfill operators want to make waste haulers use their landfill so they can make enough money to pay for operating the landfill. Of course, this will fill it up faster. Waste haulers believe they should be able to dump their garbage where it is cheapest whether it is in their own state or another.
- Which of the following statements supports the main idea of this paragraph?
- Solid waste issues can be difficult to resolve because there are too many laws telling waste haulers what they have to do.
 - State government can resolve solid waste issues by making laws.
 - Solid waste issues can be difficult to resolve because of the conflicting interests of local government control and economic and business affairs.

Short Answer

- 7** One purpose of local government is to provide solid waste management. Name two places or activities provided by local government to make sure that garbage and trash are taken care of.
- (1) _____
- _____
- (2) _____
- _____
- 8** There are a lot of people in the community who believe that recycling is important. However, the local township trustees have not paid attention to the people's requests to start a local recycling program. The supporters of recycling hold a meeting to discuss what they should do to get a recycling program started in their community. Here are some suggestions:
- march outside the township trustees offices
 - write letters in support of recycling
 - work to elect one of their own supporters to the township board of trustees
- Which of these suggestions do you think is the best one to get the results the recycling supporters want? Choose one and explain. (Answer on a separate sheet of paper.)