An Ounce of Prevention

A MIDDLE LEVEL SCIENCE CURRICULUM ON SOURCE REDUCTION

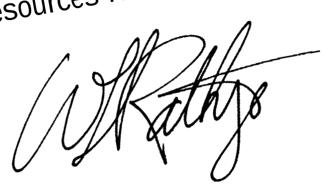
NSTA

Forward

As a frequent digger and describer of landfills, I am acutely aware of the solid waste situation in America. I have seen firsthand what is in landfills, and what isn't in them. I have also seen their growth slowed very little by our after-the-fact waste reduction efforts. Let's face it: while recycling is valuable, creating less waste is even more important.

To be successful, waste management will have to become waste prevention. Waste prevention, in turn, will have to be based on a clear understanding of the underlying causes–social, behavioral, political and physical–of discards. As teachers, you and I are in a unique position to help with this effort. That's because the education of today's students, who are tomorrow's consumers, is one of the most effective ways to assure the switch from waste management to waste prevention.

This curriculum is an excellent way for you and your students to understand the need to prevent waste and use less stuff. By learning about the benefits of waste prevention and recycling, we will move farther down the road of the real journey that lies ahead–the conservation of resources for future generations of people, plants and animals.



Dr. William L. Rathje
Professor of Anthropology
University of Arizona
Director, The Garbage Project

Acknowledgements

The National Science Teachers Association (NSTA) gratefully acknowledges the hard work of the following people and organizations, without whom this curriculum could not have been developed or completed.

- Crystal Lal, who organized, edited and managed the project for the NSTA;
- Pam Ashford, Page Keeley, Inez Liftig, Janet Peeler and Pat Warren are the dedicated teachers who wrote and edited the lessons;
- Pam Ashford, Deer Park, WA
  William Boone, Bloomington, IN
  Glyn Brice, Wenatchee, WA
  Charlene Czerniak, Toledo, OH
  Diane Hill, Florence, KY
  Page Keeley, Coopers Mills, ME
  Melinda Mills, Houston, TX
  Janet Peeler, Marietta, GA
  Suzanne Spradling, Oklahoma City, OK,
  our panel of beta-testers who used the activities in their classrooms and provided valuable suggestions for revisions;
- Dr. William Rathje of the University of Arizona, who acted as technical advisor;
- Bob Lilienfeld, editor of The ULS (Use Less Stuff) Report, who developed the "Ounce of Prevention" concept and oversaw final production;
- Tony Kingsbury, of The Dow Chemical Company, who acted as technical advisor and liaison to Dow.

We also wish to thank the Dow Chemical Company, which sponsored the development and production of *An Ounce of Prevention.*

Printed on recycled paper

Contents

Curriculum Guide

I. Introduction

We all know how important it is to recycle. But let's stop and think about why we do it. It's to reduce waste, isn't it? Aren't we really trying to keep from throwing things away, thus conserving our precious resources?

Recycling is working, but it's only the first step.
From this perspective, we can begin to understand why recycling alone can't solve all of our solid waste problems. For instance, the U.S. Environmental Protection Agency (EPA) states that our national recycling rate is 22 percent. Many experts feel that we will never get past the 33 percent level. There is just too much stuff, and the cost to recycle more will probably be greater than what our society cares to spend.

Also, recycling is a process like any other manufacturing process. It uses energy and creates both pollution and waste of its own. Recycling will create new jobs, but many will be moved from nonrecycling industries and others will be low-paying, low-skilled jobs such as collecting, sorting and transporting used materials.

What else should we be doing?
What can we do to ensure that our recycling efforts do the most good? Let's start by remembering three little words: *reduce, reuse* and *recycle.* Which one comes first? It's reduce. And it's first for a reason. It's better not to create waste than to have to figure out what to do with it. As Benjamin Franklin said, "*An ounce of prevention is worth a pound of cure.*"

Enter source reduction, or waste prevention.
Reducing is technically known as *source reduction.* It means minimizing the use of materials and energy so that we can save resources, reduce pollution and significantly cut down on the creation of toxic and hazardous waste. Eliminating waste in the first place is the real reason why reducing comes before recycling: reducing is proactive, while recycling is reactive.

How do source reduction and recycling compare?
An easy way to understand the difference between reducing and recycling is to think about brushing your teeth. If you are proactive and brush your teeth well, your visits to the dentist will be short, painless and inexpensive. But if you don't brush well, the dentist will have to fix your teeth by drilling out cavities. That's reactive, painful and expensive. Obviously, the better choice is not to have any cavities.

If you're like most people, this concept of source reduction is fairly new. But once you understand it, the merits are obvious. Your students are the same way: they know about the need to recycle, but need to learn about how to reduce waste. That's where this program can help.

What will my students learn?
The goals of this program are to:

1. Help students learn about the value of source reduction and its place in the hierarchy of solid waste solutions.

2. Provide a basis for students' thinking about the need to conserve all types of resources, including materials, energy, water and air.

3. Provide an interdisciplinary learning approach that fosters sound thinking and the development of good research techniques.

4. Enhance the learning and use of scientific skills, tools and concepts relevant to most middle school science curriculae.

II. How the Program Works

We've developed a series of six sections that present knowledge in a step-by-step fashion. Section 1 logically and thematically comes before Section 2, Section 2 precedes Section 3, and so on. At a minimum, try to use one activity from each section to ensure a logical flow of both information and learning.

Section 1 provides background information on garbage–where it comes from, its composition and patterns of change over the years. In Section 2, students will learn where garbage goes when it leaves their homes, and why it's so important to reduce. The concept of source reduction is introduced as well.

Section 3 tackles a big trash issue–packaging–which accounts for a third of household waste. By reducing the amount of packaging we use, we can make a big dent in the amount of garbage we produce. Students will learn how to reduce packaging, and find a few surprises along the way.

Section 4 discusses hazardous waste. Reducing the use of toxic materials around the home can help minimize water and ground contamination. Section 5 then begins to tie everything together by exploring the concept of Life Cycle Analysis, which studies the environmental effects of products and processes from a cradle-to-grave perspective.

Finally, it's your students' turn to test their knowledge and make a difference. Section 6 gives you a variety of hands-on projects designed to reduce waste at school and at home. We've included a Quiz you can use after finishing the lessons. You'll find it and the answer sheet on pages 15–18.

III. Overview

Section 1
Getting the Facts About Garbage

Let's start with a basic course in trash, so students understand how much garbage we create, where it comes from and where it goes.

Activity 1
A Big Waste Problem, No Matter How You Slice It

Students will learn what exactly goes into our trash. They will also discover differences between weight and volume, and be able to explain why these differences occur and what they mean.

Activity 2
Generations of Waste

As long as there have been people, there has been trash. But the composition of trash has changed as society has changed. In this lesson, students will go on "archaeological digs" to determine different living patterns in American societies over the last 300 years. The evidence for their findings? Garbage!

Activity 3
Today's Waste: What's in My Trash?

If students liked learning about the past from going through "old" garbage, there'll really enjoy investigating our society by analyzing their own trash. This activity works as an extension of the previous one or can be used as a stand-alone lesson.

Section 2
Introducing Source Reduction

If we're still creating garbage faster than we can figure out what to do with it, maybe it's time to create less trash.

Activity 4
Where Does the Trash Go?

Out of sight, out of mind. That's how we usually think (or don't think) about trash. In this lesson, students will learn about the four basic options for waste: composting, recycling, incineration and landfilling. At the end, they'll start thinking about ways to prevent or eliminate garbage, leading into the main topic of this curriculum—source reduction.

Activity 5
Island Survival

You're on an island with a few other people. There's only so much you can bring, and you can't leave anything behind when you leave. What's the best strategy to ensure your survival without creating too much waste? What does the ability to survive on an island say about our ability to survive on the Earth? This is a highly creative way to introduce the concept of source reduction.

Section 3
Producing Less Packaging

Packaging takes up a third of our municipal solid waste. How can we use less? Students will learn about ways to reduce packaging and discover that packages serve some very useful purposes.

Activity 6
Physical Properties of a Package

What is a package? What functions does it serve? Why are some light and others heavy? Some strong and others flimsy? Students will start thinking about why packages are the way they are, and get a feel for ways in which packaging can be reduced.

Activity 7
A Juicy Investigation

What's the most environmentally efficient way to serve orange juice? Fresh squeezed? In plastic containers? Glass bottles? The answer may surprise you and your class. This activity combines good critical thinking plus analytical skills to determine the best way to get one's fill of Florida (and California) sunshine.

Activity 8
Coffee Conundrum

What would the morning be without a cup of fresh-roast coffee, brewed right from the can? What about from a brick pack, instead? These new packages are not as recyclable as steel, but they are incredibly efficient in terms of energy and waste savings. The class will build on Activity 7 to learn ways to perform an in-depth environmental analysis. The winner? The most source-reduced package, of course.

Section 4
Reducing Hazardous Waste

Packaging isn't the only kind of waste we need to reduce. There are lots of hazardous wastes being dumped into the environment—many from our own homes. Reducing toxic waste is a large part of source reduction.

Activity 9
What's Hazardous about Household Products?

Did you know that EPA officials are more concerned about the hazardous waste in landfills than with the landfills themselves? Or that the typical American home may contain gallons of hazardous or toxic liquids? Your students will learn about household products that are potentially hazardous or toxic, and ways to replace them with safer yet effective alternatives.

Activity 10
Finding Safer Substitutes

What's the best way to polish silver? What is tarnish, and how can we remove it safely? Students will learn the answers and find inexpensive, safe and effective ways to replace standard products that may be classified as irritants, corrosives or toxics.

Section 5
Seeing the Whole Picture

By now, your class will have learned about the various pieces of the source reduction puzzle: reducing materials, energy and toxic substances. This section will help students tie these ideas together through the emerging field of Life Cycle Analysis (LCA).

Activity 11
Life Cycle Analysis: Retrace Your Waste

What's the real environmental impact of a fast-food hamburger? Students will learn to see the whole picture by considering the materials and energy it takes to grow, produce and transport all of the ingredients: beef, condiments and packaging. A key learning point is the fact that most waste and pollution occurs before we take that first bite!

Activity 12
Paper or Plastic? A Life Cycle Analysis Perspective

Which of these alternatives reduces waste the most? Students must compare weight and volume, along with energy consumption and the amount of water and airborne pollutants created during the production, transportation and recycling of both. Reuse of bags is also brought into the equation. The results may surprise you.

Section 6

Making a Difference

The time has come for students to apply what they've learned to their everyday lives. These activities will help to reduce waste at school, at home and in the office.

Activity 13
Can We Really Reduce Our Cafeteria Waste?

Do students know how much waste is created in a lunchroom? They'll find out by studying their trash and that of their classmates? They will also develop strategies to reduce the waste.

Activity 14
The Great Paper Waste

More than 550 pounds of paper and paper-board are thrown away each year for every American. In this activity, students will determine what they can do to reduce paper waste, and learn why source reduction is a better solution than recycling.

Activity 15
The Decision Makers

The Governor has asked waste experts (your students) for a comprehensive plan to cut waste. Using what they've learned and the latest EPA data, they must formulate a plan and sell it to the Governor.

IV. Core Curriculum

We don't expect you'll use all the lessons. However, we do have a suggested Core Curriculum of seven activities to ensure subject mastery:

	Activity #
Section 1	1
Section 2	4
Section 3	6 and either 7 or 8
Section 4	9
Section 5	11 or 12
Section 6	Pick one

Feel free to use additional lessons.

V. Glossary

Discards
Items that are thrown away.

EPA
The Environmental Protection Agency. The arm of the Federal government responsible for regulating and protecting the environment.

Hazardous
Harmful to plants and animals.

Landfill
A site where garbage is dumped. Modern landfills are designed to seal in substances so that they can't leak into the environment. When they are filled, landfills can be capped with dirt and grass to become parks or golf courses.

Leachate
Liquids primarily from old dumps that ooze into the ground, possibly contaminating soil and underground water. From the term 'to leach' out.

Municipal Solid Waste
Garbage that is generated by homes and offices. It does not include hazardous or toxic waste.

Pollution
Contamination of air, water and soil usually caused by man-made waste. Pollution is created by burning and various manufacturing processes. (Volcanic gases and ash are examples of natural pollution.)

Recovery
Removing materials from the waste stream so that they can be reused or recycled rather than landfilled or incinerated.

Recycling
A process whereby materials are sorted, cleaned and remanufactured into new products.

Solid Waste Management
The process of controlling waste to minimize both the use of landfills and potential environmental, health and safety problems. Usually referred to as MSW, options include source reduction and composting, reusing, recycling, incineration and landfilling.

Source Reduction
Minimizing the use of materials and energy, thereby also minimizing garbage, pollution and the use or disposal of toxic materials. Sometimes known as waste prevention or pollution prevention.

Toxic
Poisonous, extremely harmful to plants and animals. May cause death.

Waste Generation
The creation of garbage.

Waste Stream
The trail of all garbage items as they move from homes, offices and factories to recycling centers, incinerators and landfills. Think of your household garbage as a small stream. Your stream and those of your neighbors form a bigger stream, which forms a river, etc.

Waste to Energy
The burning of waste to produce energy. Usually, the burning produces steam, which is then used to make electricity. Waste to Energy is sometimes abbreviated as WtE or wte.

VI. Other Statistical Resources

For the latest EPA facts and figures, call your local EPA branch or the main office in Washington and ask for Document # EPA530-R-94-042, Characterization of Municipal Solid Waste in the U.S.–1994. (Note: This document is updated every two years. Ask for the most recent study.)

If you have Internet World Wide Web access, this and related documents are available at:

http://www.epa.gov
Use the search field and enter the letters MSW.

VII. Further Reading

The ULS (Use Less Stuff) Report
For a free subscription, send a self-addressed, stamped envelope to ULS, Box 130116, Ann Arbor, MI 48113. Or look up Use Less Stuff on the Internet: www:http://cygnus-group.com

Choose to Reuse
by Nikki & David Goldbeck, Ceres Press, 1995

In Our Backyard
by Travis Wagner, Van Nostrand Reinhold, 1994

Rubbish! The Archaeology of Garbage
by William Rathje & Cullen Murphy, Harper Perennial, 1992

The Total Package
by Thomas Hine, Little, Brown, 1995

VIII. Materials

All handouts are included with the activities. A few charts will be used throughout this curriculum, including weights and volumes of different types of solid waste. Rather than include them each time they're needed, we decided to source reduce and provide them once. You'll find them at the end of this introduction.

Chart	Title
1	Materials Generated in MSW* by Weight
2	Products Generated in MSW by Weight
3	Management of MSW in U.S.
4	Landfill Volume of Materials in MSW
5	Landfill Volume of Products in MSW
6	Generation of Materials in MSW
7	Materials Recovery and Discards of MSW

**Municipal Solid Waste*

STUDENT HANDOUTS

For easy reference, all handouts are marked with a running head on each page.

Activity 1
What's in Our Trash? Pie Chart Recording Sheet

Activity 2
Site Sheets A,B,C,D,E Artifact Code Sheets
Site Report Sheet, Tally Sheet and Archaeological Convention

Activity 4
Pie Chart Recording Sheet (see Activity 1)
Where Does the Trash Go? Waste Disposal Chart

Activity 5
Island Survival Sheet and Item List

Activity 6
Properties of a Package Data Tables

Activity 7
Orange Juice Packaging Analysis Worksheet

Activity 8
Coffee Conundrum Worksheet

Activity 9
Classifying Hazardous Household Waste Data Record

Activity 10
Safer Substitutes Worksheet

Activity 11
Life Cycle Inventory
Life of a Hamburger Poster

Activity 12
Paper or Plastic? Life Cycle Analysis Worksheet

Activity 13
Cafeteria Trash and Waste Observations Data Table

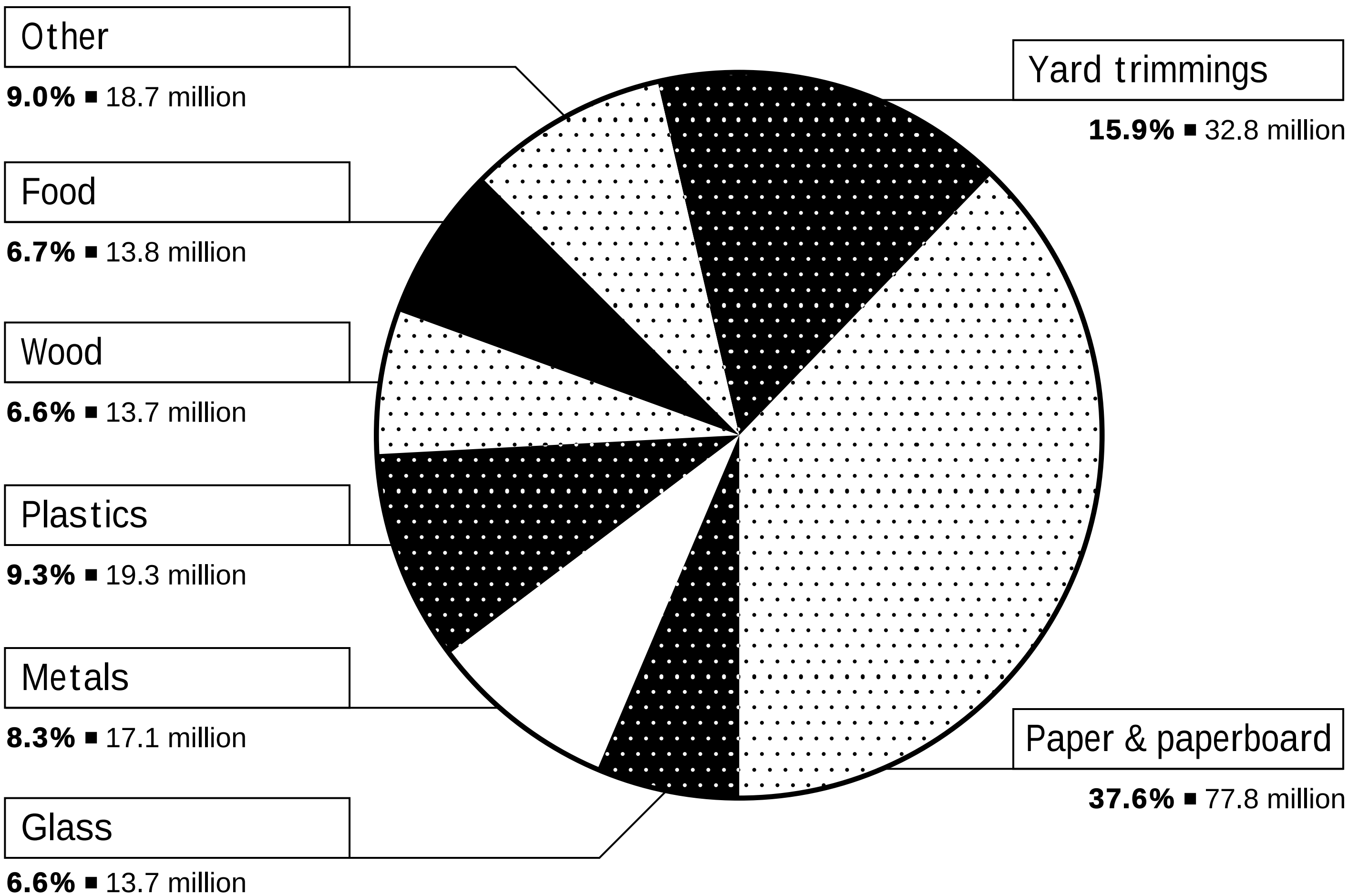
Activity 14
The Great Paper Waste Worksheet

Activity 15
Decision Grid

CHART 1

Materials Generated in MSW by Weight, 1993

Total weight = 206.9 million tons. All figures in tons

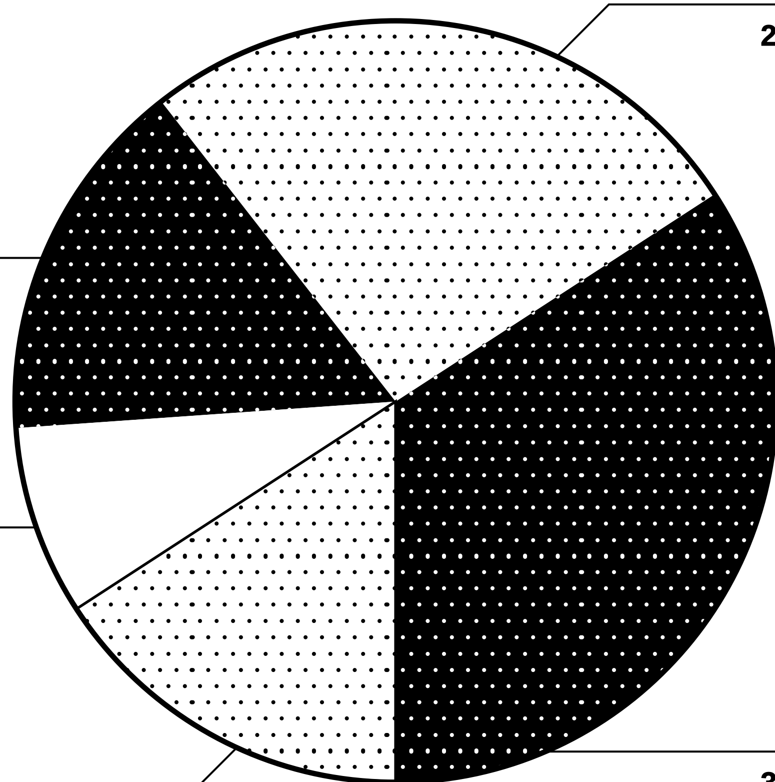


Source: EPA Characterization of Municipal Solid Waste in the US–1994

CHART 2

Products Generated in MSW by Weight, 1993

Total weight = 206.9 million tons. All figures in tons

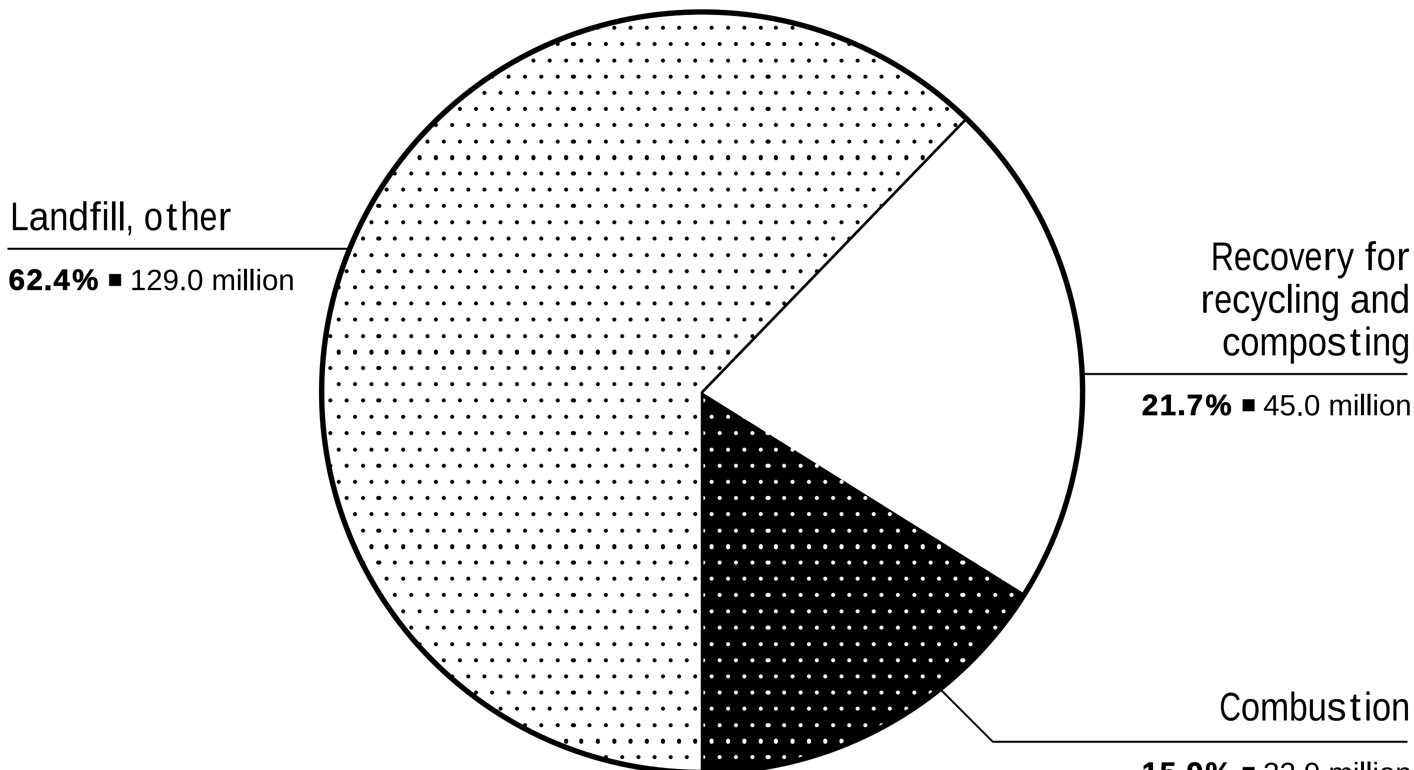


Source: EPA Characterization of Municipal Solid Waste in the US–1994

CHART 3

Management of MSW in U.S., 1993

Total weight = 206.9 million tons. All figures in tons

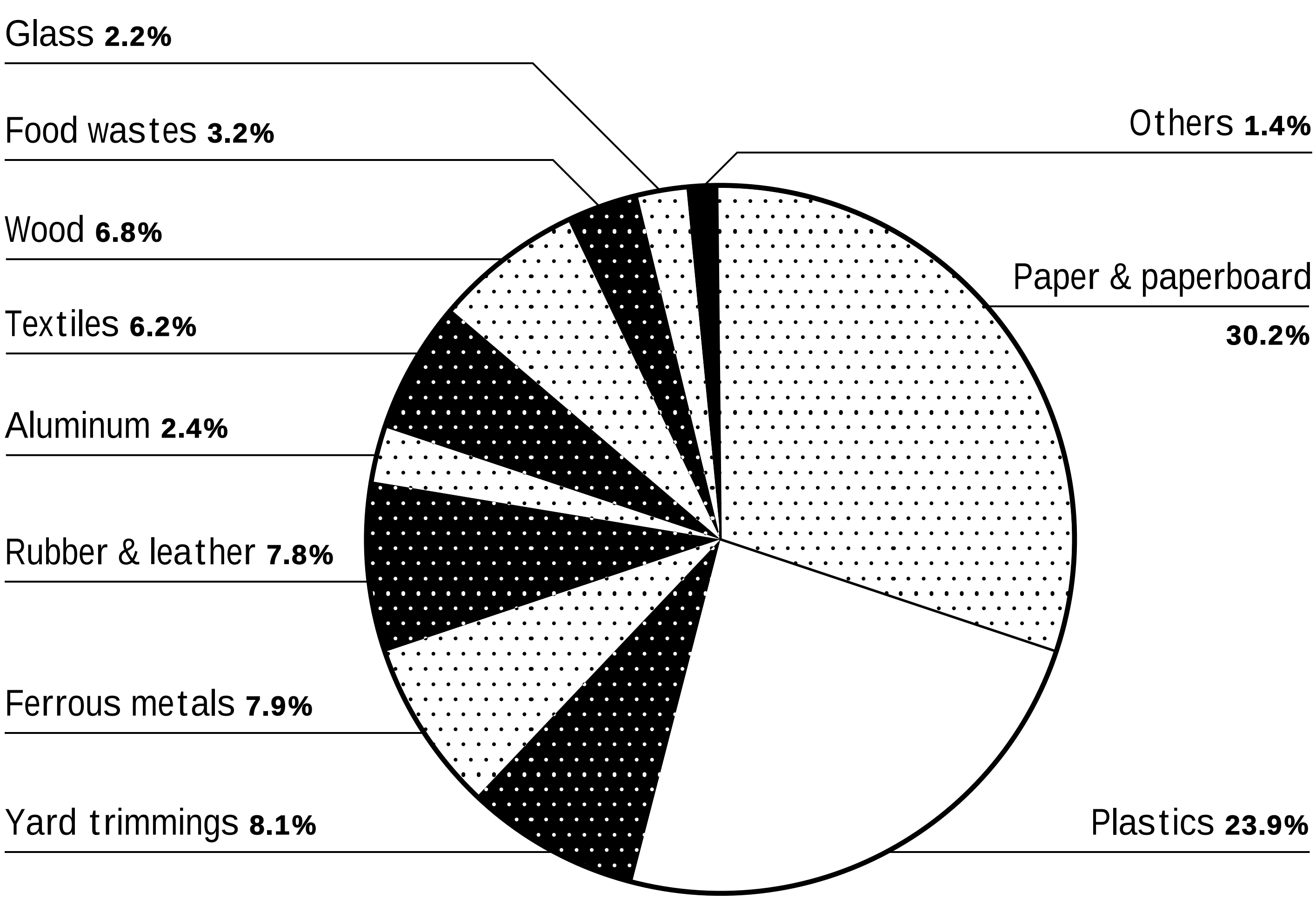


Source: EPA Characterization of Municipal Solid Waste in the US–1994

CHART 4

Landfill Volume of Materials in MSW, 1993

Percent of total volume

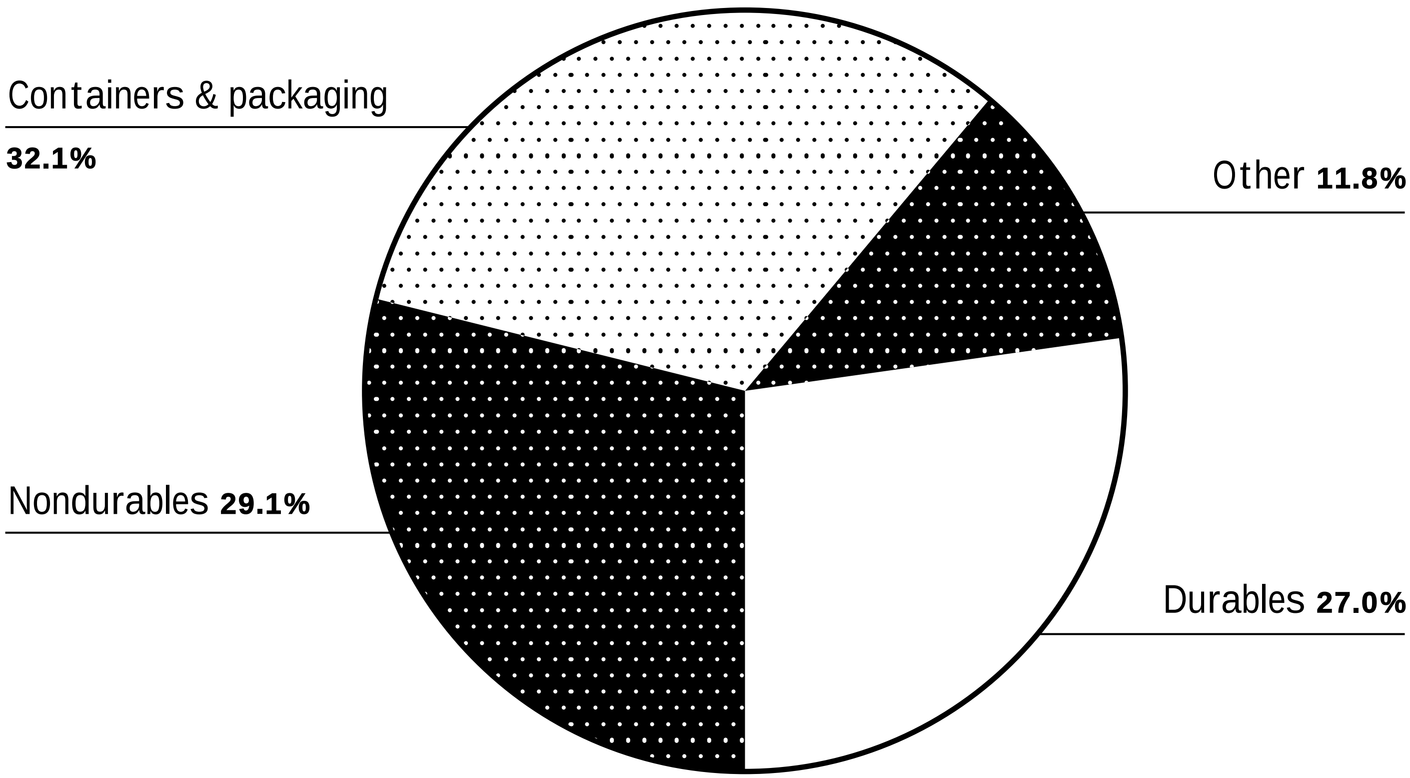


Source: EPA Characterization of Municipal Solid Waste in the US–1994

CHART 5

Landfill Volume of Products in MSW, 1993

Percent of total volume

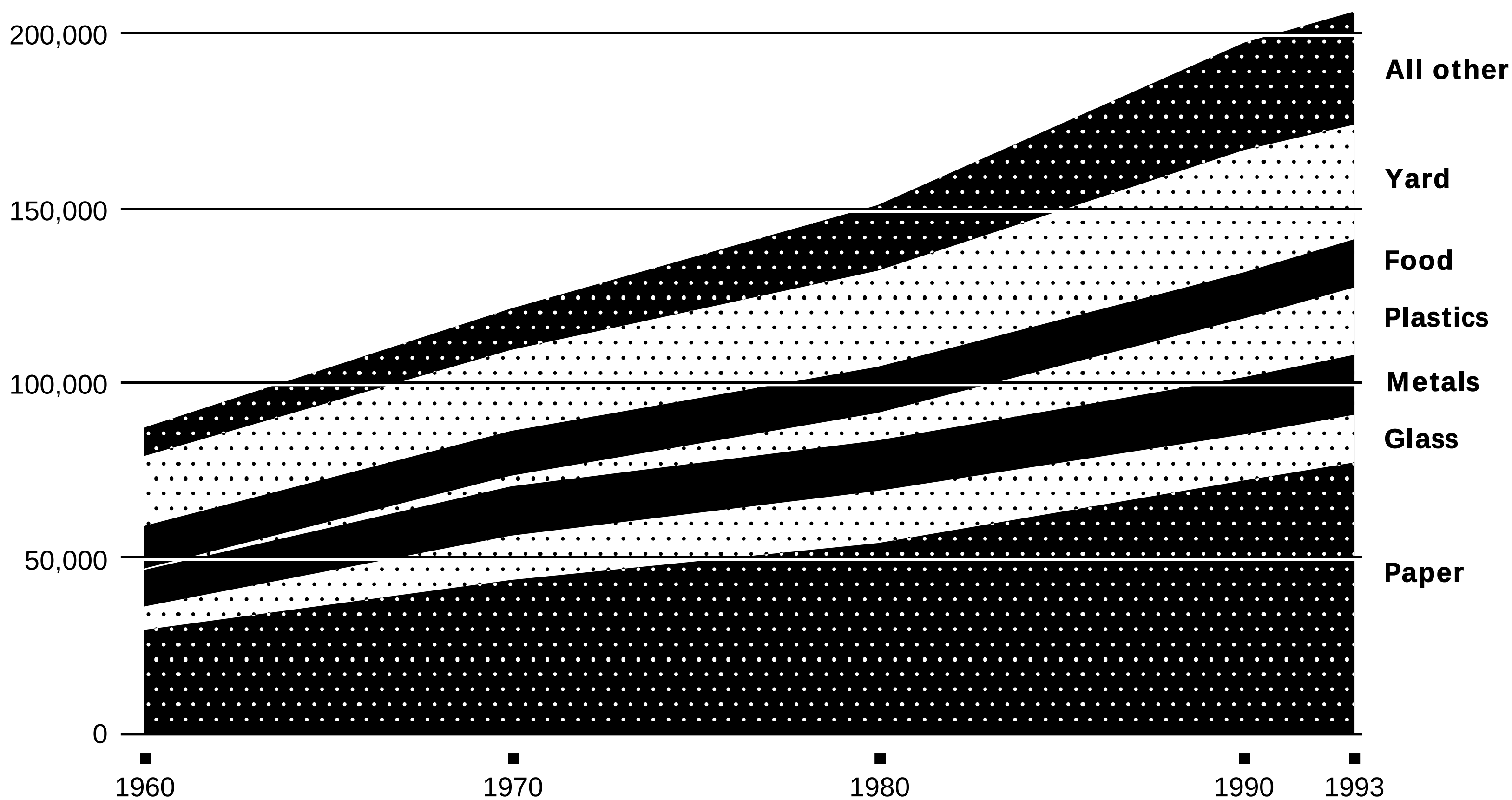


Source: EPA Characterization of Municipal Solid Waste in the US–1994

CHART 6

Generation of Materials in MSW, 1960 to 1993

In thousand tons

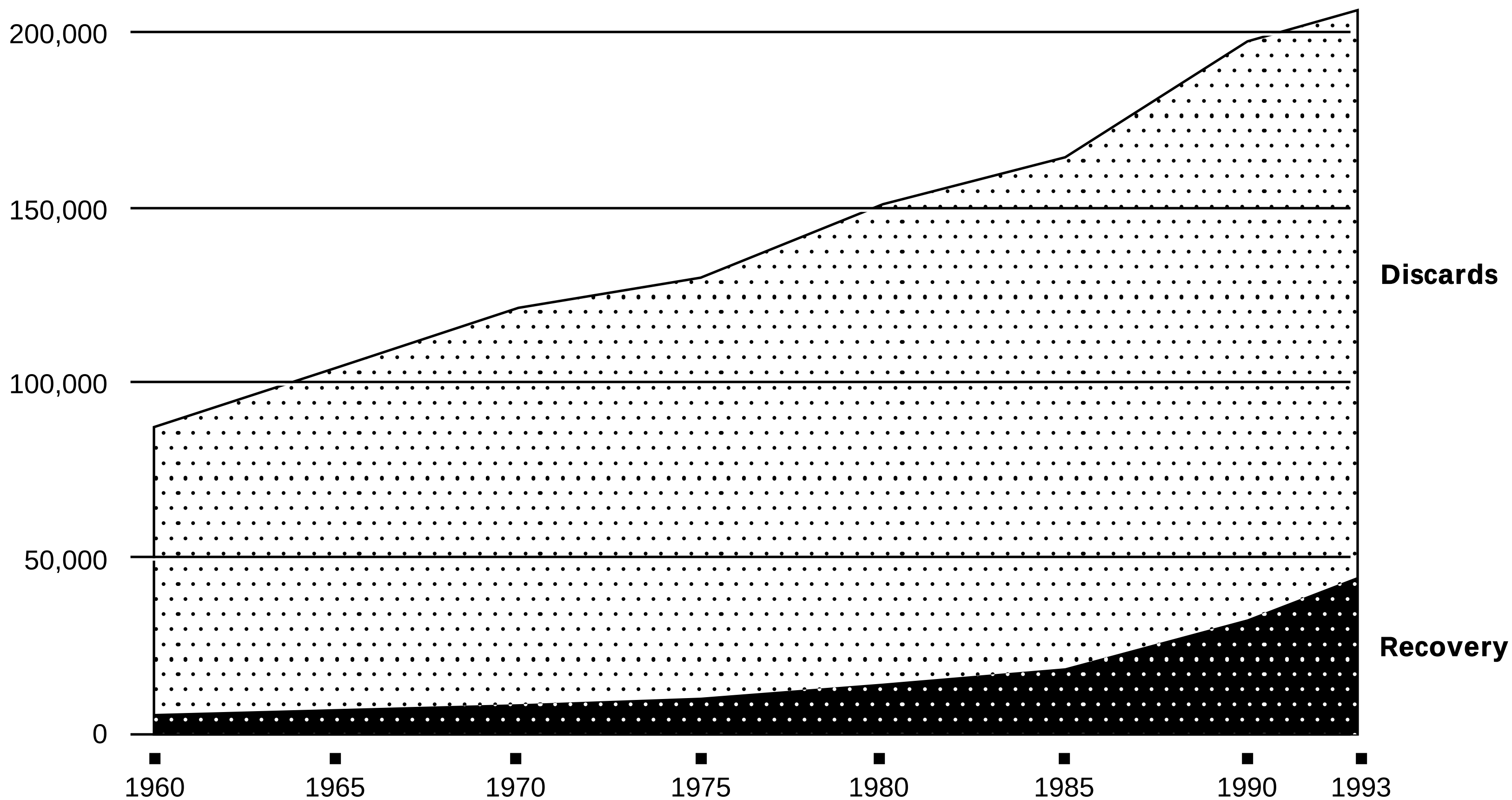


Source: EPA Characterization of Municipal Solid Waste in the US–1994

CHART 7

Materials Recovery and Discards of MSW, 1960 to 1993

In thousands of tons



Source: EPA Characterization of Municipal Solid Waste in the US–1994

A Big Waste Problem

N O M A T T E R H O W Y O U S L I C E I T

C O N T E N T A R E A S

- **Math**
  percentages, pie-chart graphs, volume, ratios
- **Social studies**
  business, industry, community
- **Science**
  solid waste, prediction, classification, measurement of weight and volume, verification

O B J E C T I V E S

Students will…

- recognize that there are many kinds of garbage generated by a variety of sources
- classify trash and predict the percentage of each trash category in the total solid waste stream
- discuss and debate the actual percentages and compare them against their predictions
- observe the difference between weight and volume of trash categories

M A T E R I A L S

For groups of three or four students

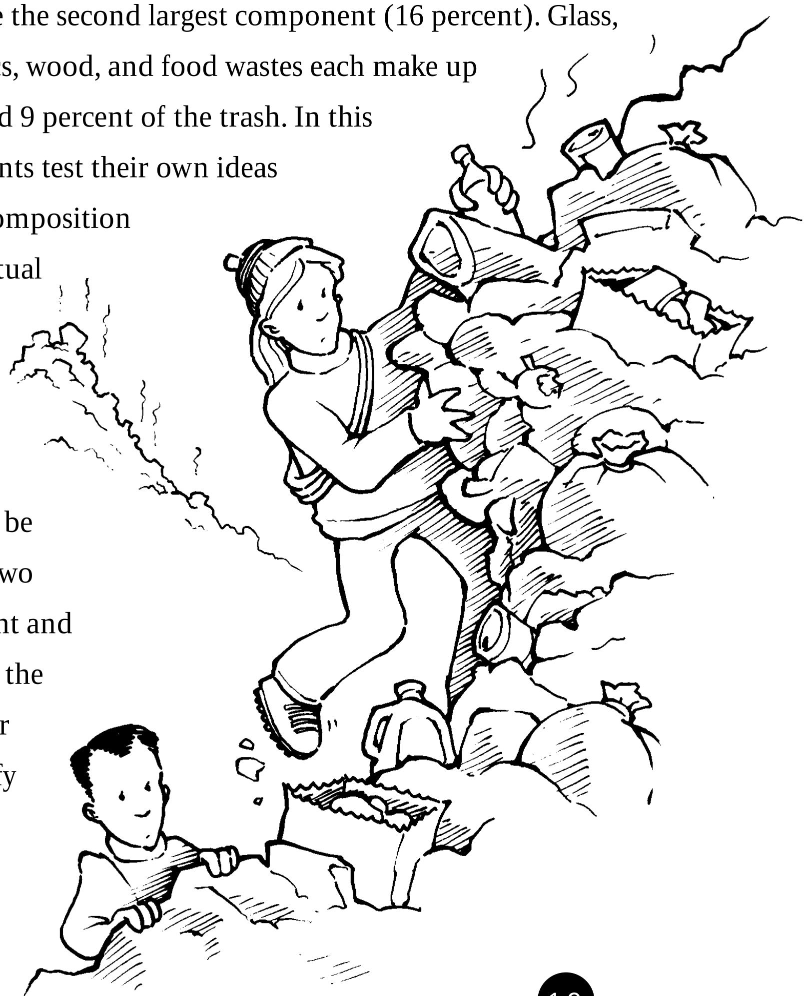
- *What's in Our Trash?* Pie Chart Recording Sheet

T I M E

Two periods
45 minutes each

Americans generate more than 200 million tons of garbage each year. No question, that's a lot of trash. But to begin to solve our garbage problem, we need to understand garbage better. What is in our trash? To answer this question without digging through dumpsters or tramping through landfills, this activity uses figures from the most recent (1994) U.S. Environmental Protection Agency (EPA) report that characterizes municipal solid waste.

The figures are surprising: paper and paperboard products are the largest component (38 percent) of the waste stream, and yard trimmings are the second largest component (16 percent). Glass, metals, plastics, wood, and food wastes each make up between 7 and 9 percent of the trash. In this activity, students test their own ideas about trash composition against the actual EPA figures. They also come to understand that trash can be measured in two ways, by weight and by volume. In the end, no matter how we classify the trash problem, it's a big one.



PART 1

Pie Chart Activity

PROCEDURE

1. Introduce the activity by asking the class to respond to this question in writing or as part of a discussion: "Where does garbage come from?" Have the students list as many places as possible. (See Teacher Notes for a list of sources to use as prompts.)

2. Share the answers and compile a class list of trash sources on the chalkboard or on an overhead.

3. Divide the class into groups of three or four students. Ask each group to look at the class list and write down as many different items of trash as possible that each source would generate. If the list of sources is lengthy, assign each group a different set of sources to brainstorm. You might also want to set a time limit on this part of the activity.

As an example, a restaurant is a source of garbage. Trash items would include food scraps, food packaging, napkins, old menus, receipts, paper hats worn by kitchen workers, and so on.

4. Ask the groups to classify their list items into major categories of trash with one category reserved for "other." (Examples of categories include paper, wood, clothes and glass.)

5. As a class, share the groups' lists of categories and establish a master list of categories that all groups will use to complete the activity. Although groups may initially come up with different categories, guide them to using these EPA classifications: paper and paperboard products, plastics, yard trimmings, metals, rubber/leather, textiles, wood, food, aluminum, glass, and "other." List these categories on the chalkboard or overhead.

6. Give each group a copy of the Pie Chart Recording Sheet, *What's in Our Trash?* Ask students to decide which category of trash is represented by weight in each section of the pie graph.

7. Ask each group to report to the class which category of trash they think each section represents. Which categories of trash do they think account for the largest percentage of solid waste? Which categories are the smallest contributors? Encourage debate and have each group support its choices.

8. Reveal the correct Environmental Protection Agency (EPA) answers to the pie chart. (See Teacher Notes and Charts 1 and 4 for the answers.)

QUESTIONS

Have the students compare the EPA answers to theirs and analyze reasons for any differences that they find. This can be accomplished by their answering these questions in writing or as part of a discussion:

a. In general, were you correct in identifying the largest components of the solid waste stream?

b. Were you surprised to find out the actual figures?

c. How does reality compare to your predictions?

d. How does this information affect your perception of the nation's trash problem?

e. What are some factors that could cause your answers to be different from those provided by the EPA? How would season of the year or region of the country affect these percentages?

EXTENSIONS

1. Have each group formulate a plan to scientifically verify the EPA figures. Share the plans. Discuss the variables/problems in each of the procedures.

2. Have students enlarge their graphs and depict the information as a collage. Provide magazines and newspapers for picture cutting, labels from trash items, or have students illustrate the various categories.

PART 2

Weight/Volume Demonstration

INTRODUCTION

The pie chart in Part 1 represents the percentage of each category of trash by weight. How would the chart change if it represented each category of trash by volume? Volume measures the amount of space an object takes up. Some trash has a higher volume than weight– that's why it's compacted before hauling. A teacher-led demonstration to illustrate this can be done using discarded sheets of paper from the recycling bin.

MATERIALS

for class demonstration

- empty gift box
- stack of flat 8.5 x 11-inch paper from the recycling bin

PROCEDURE

To involve students in the demonstration, ask for volunteers to help you with the following steps. Alternate volunteers from the various groups to include as many students as possible.

1. Find an empty gift box large enough to hold flat sheets of 8.5 x 11 inch paper.

2. Weigh the box and record the figure on the chalkboard or overhead. Measure the box's length, width and height. Record the figures. Have students copy the figures on paper and calculate the box's approximate volume:

Volume(V) = length(l) x width(w) x h(height)
Record the figure.

3. Fill the box with flat sheets of paper from the recycling bin. Neatly stack the sheets and count how many it takes to fill the box. Weigh the box and the paper. Ask all students to subtract the weight of the empty box from the weight of the box full of paper. This number is the weight of the paper alone. How much is it? How many sheets did the box hold?

4. Now crumple enough sheets of paper and place them into the box to the top. Do not compact the paper. Count the number of sheets required to fill the box. Weigh the box and the paper. Subtract the weight of the empty box from the weight of the box and the paper. This is the weight of the crumpled paper alone.

QUESTIONS

Ask students the following questions as part of a class discussion:

a. How does the weight of the stacked paper compare to the weight of the crumpled paper? How do the number of sheets compare?

b. How does the volume of the stack in the box compare with the volume of the crumpled paper in the box?

c. How could you get more sheets of crumpled paper into the box? Students will most likely be able to tell you to compact or "crunch" the paper. Ask them why this would work. (You are reducing the space between the pieces of paper.) Have a student try the process without breaking the box. Compare the weight and number of compacted sheets with the loosely crumpled paper and with the stacked, flat paper.

d. Which is more a problem in a landfill–volume or mass? (The volume of trash is more of a problem. It causes the available space to be used quickly by very lightweight or loose fitting items. Landfill capacity is measured by volume, not by the weight of the material placed in it.)

e. How would you reduce the volume of loose, lightweight waste in a landfill? (Compact them.)

PART 3

Volume/Weight Activity

PROCEDURE

1. Provide the EPA figures that categorize the solid waste stream by volume of trash.

2. Have the students or student groups construct a pie chart of this data. You might have to teach the students how to use a protractor and compass and how to show (the percentages have already been "determined" by the EPA) the percentages using a circle. Use a computer if possible.

3. Have students analyze/compare their pie charts of trash by volume with their pie charts of trash by weight and answer questions such as these:

a. Which items have different percentages for volume and weight?

b. Which items have a larger percentage for volume than for weight?

c. Which items have a larger percentage for weight than for volume? How can you explain this? (Items such as yard grass clippings, wood chips and dead leaves are very compact and weigh more but take up a relatively smaller percent age of total volume. Items such as plastic don't weigh much, but the types that are hard to compact take up a relatively larger percentage of total volume.)

d. Why is compacting trash important?

EXTENSIONS

1. Investigate to see if your town or city pays to haul and dump its trash by weight or by volume. If you were paying by weight, which would be the least expensive per container or load–crumpled, compacted, or stacked paper? Which form of paper would be best if you were paying by volume?

2. Determine the different densities of the same box with a) stacked paper, b) loosely crumpled paper and c) compacted paper. Use the formula $D=M/V$.

Teacher Notes

SOURCES OF TRASH

- schools and universities
- libraries
- industries, factories, mills, refineries, chemical producers
- printers, publishers, copy centers
- dry cleaners, laundromats
- cafeterias, restaurants
- homes, farms, yards
- business, government offices
- stores, malls
- movie theaters
- slaughter houses, food preparation factories
- auto repair shops, body shops
- construction, demolition firms
- automobile service centers/body shops
- hospitals, clinics, doctors' offices, laboratories

ANSWERS TO THE PIE CHART RECORDING SHEET

What's in Our Trash?

See page 26 for answers to the Student Handout, which deals with waste in tons. Chart 4 in the Materials Section of the Curriculum Guide shows the volume of materials in our landfills. The chart below summarizes landfill waste in terms of both weight and volume.

Landfill Materials in Solid Waste, 1993

% of Solid Waste

	By Weight*	By Volume**
Paper & paperboard	38	30
Yard trimmings	16	8
Plastics	9	24
Metals	8	10
Glass	7	2
Wood	7	7
Food	7	3
Other	9	16

**See Chart 1 in Curriculum Guide*

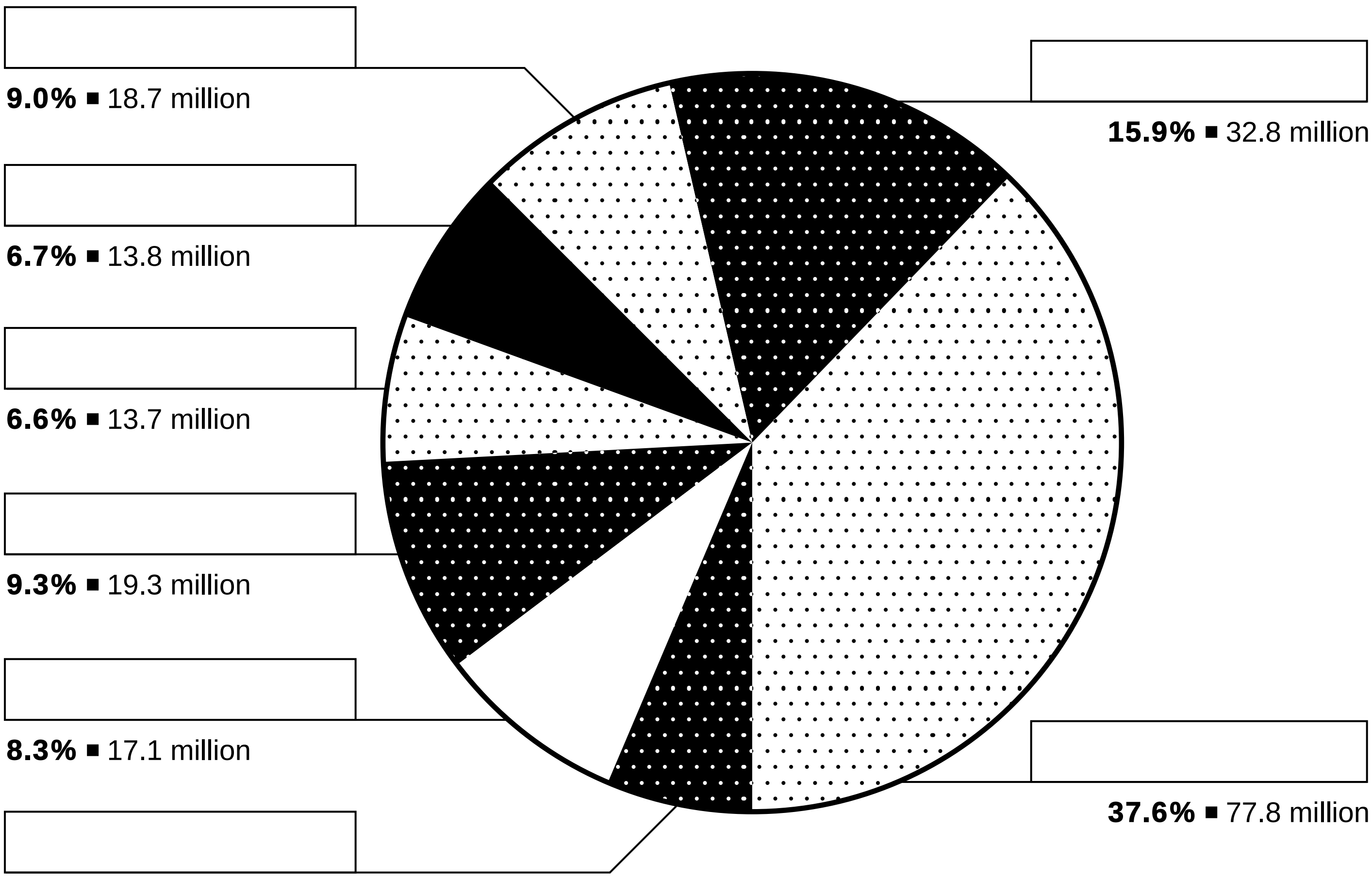
***See Chart 4 in Curriculum Guide*

Source: EPA Characterization of Municipal Solid Waste in the US–1994

What's In Our Trash?

PIE CHART RECORDING SHEET *(Figures in tons)*

Write your choices in the boxes



Source: EPA Characterization of Municipal Solid Waste in the US–1994

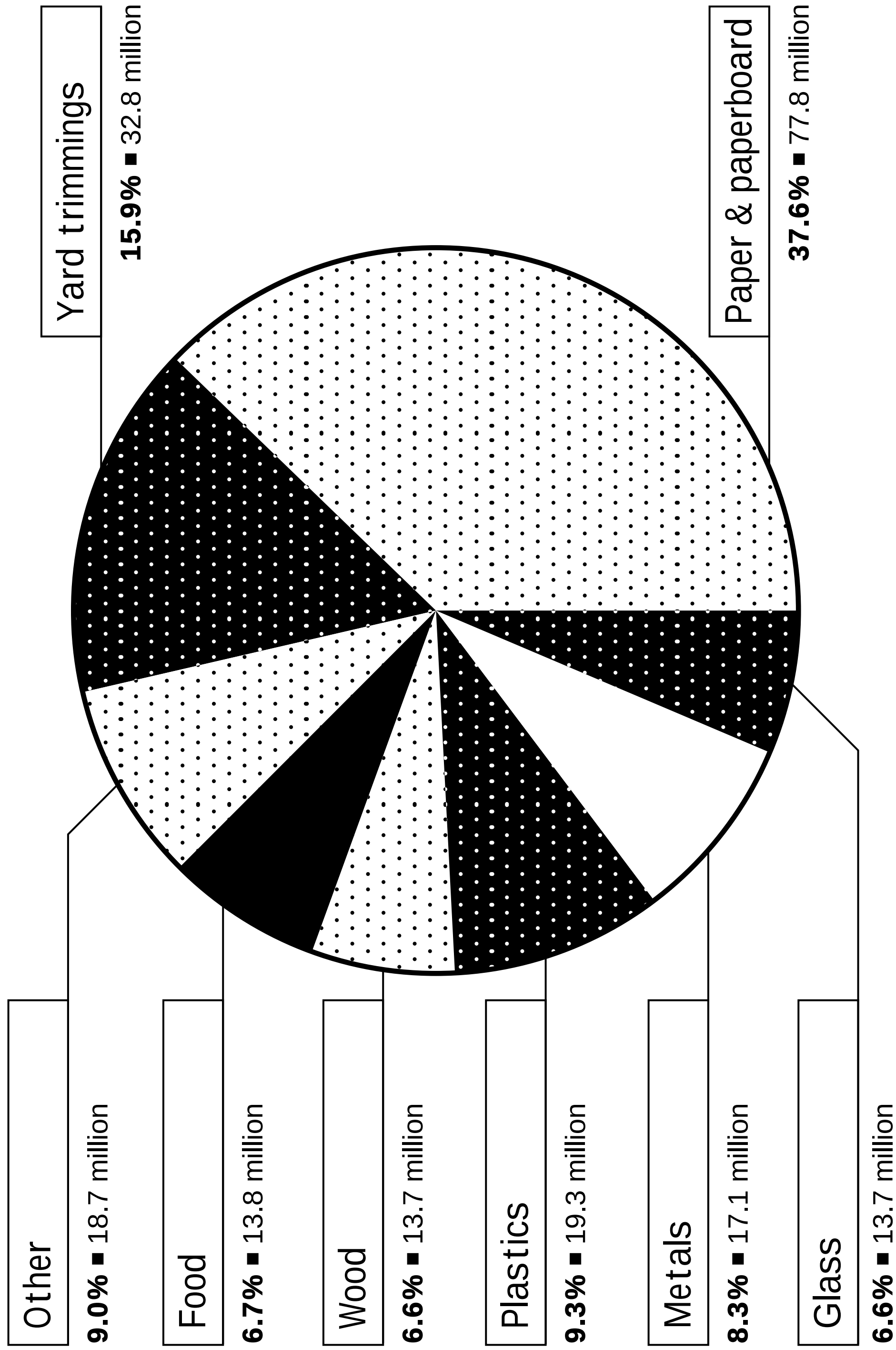
Choices

- Food
- Glass
- Metals
- Other
- Paper and paperboard
- Plastics
- Wood
- Yard Trimmings

Answer Sheet: What's In Our Trash?

Materials Generated in MSW by Weight, 1993

Total weight = 206.9 million tons. All figures in tons



Source: EPA Characterization of Municipal Solid Waste in the US–1994

Generations of Waste

CONTENT AREAS

- **Science**
  archaeology, classification, prediction, verification
- **Social Studies**
  American history, family structure, lifestyle

OBJECTIVES

Students will. . .

- identify, determine the amount, and classify the trash produced by a typical family from a historic time period
- understand how family lifestyles throughout American history have changed
- relate these changes to the amount and type of trash generation

MATERIALS

For groups of four to six students

- Artifact Code Sheet (one for each member)
- Site Sheets A, B, C, D, or E *Waste from Generation to Generation* (one for each student)
- Tally Sheet (for each group)
- Site Report Sheet and Presentation Organizer (for each group)
- Archaeological Convention (handout for each group)

TIME

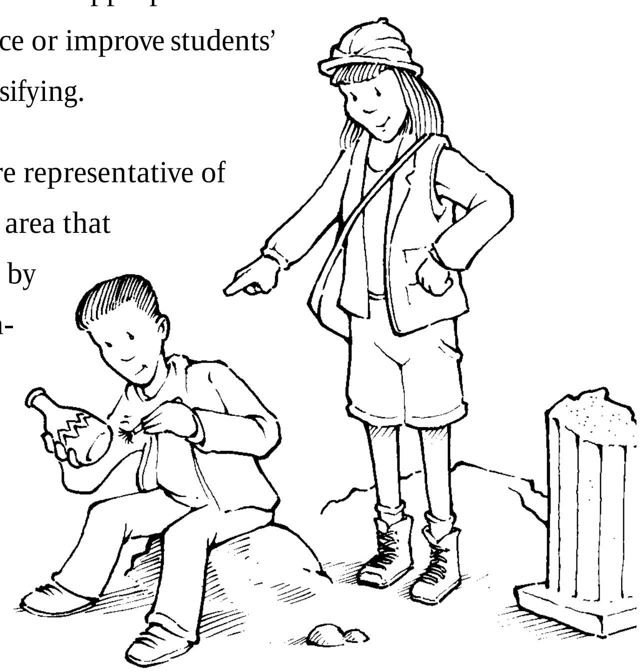
Three periods
45 minutes each

Trash is not a modern phenomenon. Since the dawn of civilization, humans have had to deal with their waste. What has changed over the course of history is the amount and kinds of trash we produce. This activity is a simulated archaeological dig that allows students to deduce a particular historical time period based on the trash that a "typical" family has discarded.

Students then analyze the trash and discuss their findings, forming a better picture of today's solid waste problems versus those in the past. For example, we no longer worry about what to do with horse manure. But we do have to deal with used batteries, an unknown issue 100 years ago.

This activity has a definite interdisciplinary flavor. It asks students to identify historical periods based on the trash that they find. The archaeologic aspect of the activity connects with both science and social studies. This activity is also appropriate to use in a science class to introduce or improve students' skills for identifying and classifying.

The grids for this activity are representative of a cross-sectional view of an area that might have been uncovered by an archaeological team excavating a dig site. There are five sites. The time periods are Native American, Colonial, the 1800s, 1940–1960s, and 1980–1990s.



PROCEDURE

1. To introduce the lesson, ask students to answer the following questions: What is archaeology? What do archaeologists do? How do they work? Are any of you interested in becoming an archaeologist?

2. Divide the class into five groups with four to six students in each group. Each group will identify the trash during one historical period: Site A, Native American; Site B, Colonial; Site C, the 1800s; Site D, 1940–1960s; and Site E, 1980–1990s. Do *not* reveal the time period.

Make sure that each group examines a different time period. Give every student in each group a copy of their assigned Site Sheet and an Artifact Code Sheet. Also give each group a Site Report Sheet and an Artifact Sheet.

3. You will act as a facilitator as each group "excavates" their site, identifies artifacts, and completes their Site Report Sheets. To do this, each group must:

a. Identify the items located on the site.

b. Make a list of the all materials located in the grid on the artifact sheet.

c. Count the number of each artifact found.

d. Identify the historical time period.

e. Classify the artifacts according to function:

- food
- shelter and "yard"
- food preservation/ packaging
- amusement
- cooking
- hygiene
- tools
- transportation
- hunting
- clothing

f. Determine the material(s) each artifact is made of (i.e., paper, plastic, glass, leather, food waste, metal, wood, textiles, rubber, yard waste).

g. Prepare a presentation that explains how the time period and lifestyle affected their family's trash.

4. When all groups have completed their Site Report Sheets, each group prepares and presents their information to the class.

5. When all information has been presented, lead the class in a discussion of how lifestyles have changed throughout history in the United States. Encourage discussion on how those changes have contributed to today's solid waste. The interesting discovery is that all time periods created trash: the difference is that the increase in our population's "throw away society" has led to our present solid waste situation.

QUESTIONS

a. Compare the Native American family with today's family. Identify the major differences in waste creation.

b. Did any group of people during any time period create less trash than we do today? Why or why not?

c. Is there a commonality between all the time periods? Is there any kind of trash or artifact that did not change?

d. How do you think the advances in materials science have affected lifestyles and subsequently, generating trash?

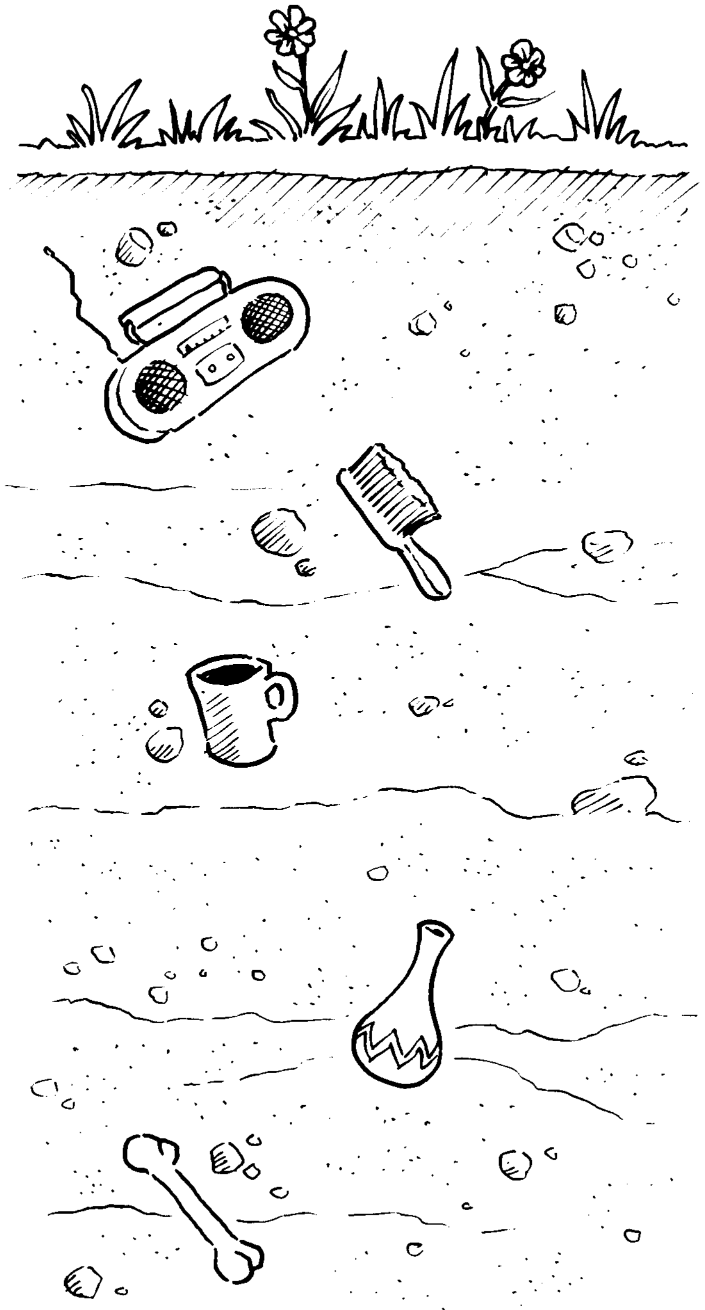
e. What kinds of problems did trash present during the various time periods? How have waste treatment methods changed?

EXTENSIONS

1. Have students research the dates when significant materials such as cloth, pottery, paper, glass, aluminum, steel, and various plastics were invented.

2. Research and develop a timeline or storyboard that illustrates the history of preservation and packaging.

3. Create a timeline of inventions that have had an affect on our lifestyles resulting in a change in what people throw away.



RESOURCES

1. Flexible Packaging Association
John S. Henderson, Manager
Educational Programs
1090 Vermont Avenue, NW
Suite 500
Washington, DC 20005-4960

2. The Dow Chemical Company
2040 Dow Center
Midland, MI 48674

3. Partners For
Environmental Progress
P.O. Box 130116
Ann Arbor, MI 48113

4. Dr. William Rathje, Director
The Garbage Project
University of Arizona

Answer Key to Artifacts List

SITE A
Native American

R7 redware pottery = 20
F2 fish bones = 18
S6 snail shells = 25
G6 gourds = 8
D4 dried berries = 26
B4 beads = 8
S11 stone tool shards = 30
B6 bird bones = 14
R3 raw hide = 2
T8 tobacco = 2
A10 ax = 1
C17 copper knife = 3
S8 spears = 4
A8 arrows = 9
F1 feathers = 8
R8 reed basket = 4
D5 dried pumpkin = 5
C19 corn or pea seeds = 26
S2 nut shells = 33
F5 fruit peels = 8
A6 antlers = 7
A5 animal fat = 4
S4 skins = 9

SITE B
Colonial

P12 potato = 13
C11 clay pipes = 26
S5 smoked fish = 18
G3 glazed pottery = 17
B8 brass pots = 7
T1 tankard (pewter) = 5
D1 deer bones = 13
C8 chicken bones = 25
L3 lead shot = 13
B9 brick = 16
B2 barrel staves = 4
C1 candles = 26
V1 vegetable leaves = 33
I4 iron nails = 8
M3 medicine bottles = 11
G4 gold beads = 3
A9 awl = 1
S9 spinning wheel = 1
A7 anvil = 2
F5 fruit peels = 2
C4 case bottles = 3
M5 metal buttons = 27
F3 fish hooks = 9
L4 leather bound book = 1
A10 ax =1
W3 wood ash = 20
F4 flint = 14
T8 tobacco = 8
L7 linen cloth = 8

SITE C
1800s

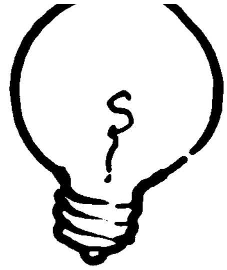
P12 potato = 13
W4 wooden pipes = 26
H1 handkerchiefs = 11
C9 china = 17
C18 copper pots = 7
G2 glasses (drinking) = 2
B5 beef bones = 13
S12 string = 9
C8 chicken bones = 25
L1 lamp chimney = 9
B9 brick = 17
B12 burlap bags = 4
F5 fruit peels = 26
V2 vegetable peels = 36
B11 butcher paper = 8
M1 mason jars = 11
W2 whale bone = 2
I1 ice pick = 1
H2 hammer = 1
I2 ice tongs = 1
J1 jar lids = 5
M2 meat grinder (hand) = 2
B7 bottles (glass) = 3
W6 woven baskets = 27
T8 tobacco = 5
T4 tin cans = 15
L4 leather bound books = 5
C20 cotton cloth = 5
W3 wood ash = 22
C6 chamber pot = 1
S3 silk cloth = 3
T6 train ticket = 2

SITE D
1940s–1960s

P1 paper bags = 13
A4 alum. t.v. dinner tray = 26
W1 wax paper wrapper = 18
M4 Melmac dishes = 17
C2 cardboard boxes = 7
S1 Sears catalog =1
R2 ration stamps = 13
B10 bus ticket = 9
C8 chicken bones = 25
C14 glass cola bottles = 13
N2 nylon stockings = 16
C3 cardboard record sleeve = 4
F5 fruit peels = 27
V2 vegetable peels = 33
B11 butcher paper = 8
S7 soap powder boxes = 11
N1 newspaper = 8
S10 steel lunch box/thermos = 1
L5 Life Magazine = 2
M8 motor oil can = 4
P14 poodle skirt = 1
W5 wooden crate = 3
C12 cloth diaper = 5
K1 Kleenex = 6
G1 glass milk bottles = 3
L6 light bulbs = 27
C10 cigarettes = 5
A3 alum. toothpaste tube = 9
P2 paper back books = 4
R4 rayon blouse = 2
R5 45 record = 2
T3 telephone bill = 3
D3 dish towels = 6
R1 radio tube = 20
T5 toilet paper roll = 3
L2 lawn clippings = 6
H1 handkerchief = 2

SITE E
1980s–1990s

P1 paper bag = 13
M6 microwave container = 26
P13 clear plastic wrap = 18
A2 aluminum can = 4
M7 milk/juice box = 7
R9 refillable detergent bottle = 2
G5 Gore-Tex jacket = 1
B3 battery (c-size) = 13
A1 airplane ticket = 3
C8 chicken bone = 10
P9 plastic CD case = 4
P6 pantyhose = 4
P10 plastic grocery bag = 4
F5 fruit peel = 8
P7 photocopy = 33
F6 foam plastic tray/cup = 5
P8 plastic bottle/jug = 11
N1 newspaper = 8
C13 cloth lunch bag = 1
L8 LL Bean Catalogue = 1
D2 disposable diaper = 5
P11 plastic pickle pouch = 1
C15 computer printer paper feed = 11
C16 computer disk = 3
P5 milk carton = 7
K1 Kleenex = 8
J2 junk mail = 13
C5 cassette tape/VCR tape = 4
T2 Teflon-coated pan = 2
T7 T-shirt = 6
x vegetable peel = 8
T3 telephone bill = 4
P4 paper towel = 15
B1 Barbara Streisand ticket = 2
T5 toilet paper roll = 3
C7 chemical fertilizer bag = 1



Artifact Code Sheet

A1	airplane ticket
A2	aluminum can
A3	aluminum toothpaste tube
A4	aluminum TV dinner tray
A5	animal fat
A6	antler
A7	anvil
A8	arrow
A9	awl
A10	ax
B1	Barbara Streisand Ticket
B2	barrel stave
B3	battery (c-size)
B4	beads
B5	beef bone
B6	bird bone
B7	bottles (glass)
B8	brass pot
B9	brick
B10	bus ticket
B11	butcher paper
B12	burlap bag
C1	candle
C2	cardboard box
C3	cardboard record sleeve
C4	case bottle
C5	cassette tapes/VCR tape
C6	chamber pot
C7	chemical fertilizer bag
C8	chicken bone
C9	china
C10	cigarette
C11	clay pipe
C12	cloth diaper
C13	cloth lunch bag
C14	glass cola bottle
C15	computer printer paper feed
C16	computer disk
C17	copper knife
C18	copper pot
C19	corn/pea seed
C20	cotton cloth
C21	cotton stocking
D1	deer bone
D2	disposable diaper
D3	dish towel
D4	dried berries/fruit
D5	dried pumpkin
F1	feathers
F2	fish bones
F3	fishhook
F4	flint
F5	fruit peel
F6	foam plastic cup
G1	glass milk bottle
G2	glasses (drinking)
G3	glazed pottery
G4	gold beads
G5	Gore-Tex jacket
G6	gourd
H1	handkerchief
H2	hammer
I1	ice pick
I2	ice tongs
I3	iron horse shoe
I4	iron nail
J1	jar lid
J2	junk mail
K1	Kleenex
L1	lamp chimney
L2	lawn clippings
L3	lead shot
L4	leather-bound book
L5	Life Magazine/black and white
L6	light bulb
L7	linen cloth
L8	LL Bean catalogue
M1	mason jar
M2	meat grinder (hand)
M3	medicine bottle
M4	Melmac dish
M5	metal button
M6	microwave entree container
M7	milk/juice box
M8	motor oil can
N1	newspaper
N2	nylon stocking with seams
P1	paper bag
P2	paperback book
P3	paper plate
P4	paper towel
P5	milk carton
P6	pantyhose
P7	photocopy
P8	plastic bottle/jug
P9	plastic CD case
P10	plastic grocery bag
P11	plastic pickle pouch
P12	potato
P13	clear plastic wrap
P14	poodle skirt
R1	radio tube
R2	ration stamps
R3	raw hide
R4	rayon blouse
R5	45 record
R6	recycled paper
R7	redware pottery
R8	reed basket
R9	refillable detergent bottle
S1	Sears catalog
S2	shells of nuts
S3	silk cloth
S4	skins
S5	smoked fish
S6	snail shell
S7	soap powder box
S8	spears
S9	spinning wheel
S10	steel lunch box/thermos
S11	stone tool shard
S12	string
T1	tankard (pewter)
T2	Teflon-coated pan
T3	telephone bill
T4	tin can
T5	toilet paper roll
T6	train ticket
T7	T-shirt
T8	tobacco
V1	vegetable leaves
V2	vegetable peels
W1	wax paper wrapper
W2	whale bone
W3	wood ash
W4	wooden pipes
W5	wooden crate
W6	woven basket

Site A: Waste from Generation to Generation

R7 F2 R7 F2 R7 F2 R7

R7 F2 R7

R7 S6 S6 S6 S6 S6 S6 S6 S6 S6 S6 R7 S6 S6 S6 S6

S6 F2 F2 F2 R7

G6 D4 D4 D4 D4 D4 D4 D5 G6 D4 D4 D4 D4

D4 D4 D4 D4 D4 D4 D4 D4

R8 C19 C19 C19 C19 C19 C19 C19 R8 S2 S2 S2 S2 S2 S2

S2 S2 S2 S2 S2 S2 R8

C19 C19 C19 C19 C19 C19 C19 C19 C19 C19

S2 S2 S2 S2 S2 S2 S2 S2 S2 S2 S2 S2 B6 B6 B6

B6 B6 B6

F5 F5 F5

R8 C19 C19 C19 C19 C19 C19 C19 C19 C19

F5 F5 F5 F5 F5

S2 S2 S2 S2 S2 S2 S2 S2 S2 B6 B6 B6

T8 A10 C17

S11 S11 S11 S11 S11 S11 S11 S11 S11 S11 S11 S11

A6 A6 A6 S8 S8 S8

A8 A8 A8 A8 A8 A8 A8 A8 D5

S11 S11 S11 S11 S11 S11 S11 F1 F1 F1

F1 F1 F1 A6 A6 A8

R3 R3 C17

S11 S11 S11 S11 S11 S11 S11 S11 T8

G6 G6 G6 G6 A5 A5 A5

S4 S4 S4 S4 S4 S4 S4 S4 S4

S6 S6 S6 S6 S6 B4 B4 B4 S11 S11 S11 B4 B4 B4

B4 B4

F1 F1 B6 B6 B6 B6 B6 R7 R7R7

D4 D4 D4 D4 D4 D4 D4 D4 G6 F2 F2 F2 F2 F2 F2 F2 F2 F2 F2 F2

S6 S6 S6 S6 S6 R7 R7 R7 R7 R7

S8 C17

A6 A6 D5 D5 D5

R7 R7 R7 G6 A5

Site B: Waste from Generation to Generation

G3 S5 G3 S5
G3 S5 G3 D1
G3 S5 D1 G3 D1
G3 D1 C8 C8 C8 C8 C8 C8 C8 C8 C8 C8
G3 C8 C8 C8 C8 C8 S5 S5 S5 G3 D1
B8 C11 C11 C11 C11 C11 C11 F4 F4 F4
B8 C11 C11 C11 C11 C11 C11 C11 C11 C11 C11 C11 C11

B2 C1 C1 C1 C1 C1 C1 C1 B2 V1 V1 V1 V1 V1 V1 V1 V1 V1 V1
V1 V1 B2 I4 I4 I4 I4 I4
C1 C1 C1 C1 C1 C1 C1 C1 C1 C1 V1 V1 V1
V1 V1 V1 V1 V1 V1 V1 V1 V1 M3 M3 M3
L7 L7 L7 B2 C1 C1 C1 C1 C1 C1 C1 C1 C1
L7 L7 L7 L7 L7
V1 V1 V1 V1 V1 V1 V1 V1 V1 M3 M3 M3 I4 I4 I4
T8 A10
I3 W3 W3 W3 W3 W3 B9 B9 B9 B9
M5 M5 M5 M5 M5 M5 M5 M5 M5 M5 M5 M5
B9 B9 B9 B9 B9
L3 L3 L3 L3 L3 L3 L3
L3 L3
F4 F4 F4 F4 M5 M5 M5 M5 M5 M5 M5 W3 W3 W3 W3 W3 W3
L4
B9 B9 B9 T8 B9 B9 B9 B9 W3 W3 W3 W3 W3 W3 W3
D1 D1 D1 F5 F5 C4 C4 C4
M5 M5 M5 M5 M5 M5 M5 M5 T8 B8 B8 B8 B8 T8 T8 T8 T8 T8 F3 F3 F3
F3 F3 F3 F3 F3 F3 C8 C8 C8 C8 C8
G4 G4 G4 T1 T1 T1 T1 T1
A7 M3 M3 M3 M3 M3 G3 G3 G3
A9 S9
A7
P12 P12 P12 P12 P12 P12
C11 C11 C11 C11 C11 C11 C11 C11 B8 F4 F4 F4 S5 S5 S5 S5 S5 S5 S5
S5 S5 S5 S5
C8 C8 C8 C8 C8 G3 G3 G3 G3 G3
F4 F4 F4 F4
W3 W3 D1 D1 D1 D1 D1 L3 L3 L3 L3
P12 P12 P12 P12 P12 P12 P12

Site C: Waste from Generation to Generation

C9 H1 C9 H1
C9 H1 L1 L1 L1 C9 B5
C9 H1 B5 C9 B5
C9 B5 C8 C8 C8 C8 C8 C8 C8 C8 C8 C8
C9 C8 C8 C8 C8 C8 H1 H1 H1 C9 B5
C18 W4 W4 W4 W4 W4 W4
C18 W4 W4 W4 W4 W4 W4 W4 W4 W4 W4 W4 W4
B12 F5 F5 F5 F5 F5 F5 F5 B12 V2 V2 V2 V2 V2 V2 V2 V2 V2 V2
V2 V2 B12 B11 B11 B11 B11 B11
F5 F5 F5 F5 F5 F5 F5 F5 F5 F5 V2 V2 V2
V2 V2 V2 V2 V2 V2 V2 V2 V2 M1 M1 M1 L4 L4 L4 L4
L1 L1 L1 L1
B12 F5 F5 F5 F5 F5 F5 F5 F5
V2 V2 V2 V2 V2 V2 V2 V2 V2 M1 M1 M1 B11 B11 B11
T6
V2 G2 B9 B9 B9 B9 B9 B9 B9 B9 B9
W6 W6 W6 W6 W6 W6 W6 W6 W6 W6 W6 W6
B9 B9 B9 B9 B9 S12 S12 S12 S12 S12 S12
W3 W3 W3 W3 W3
W3 W3 W3 W3 W3 W3 W3 W3 W3 W3 W3 W3 W3
L1 L1 W6 W6 W6 W6 W6 W6 W6
S3 S3 S3
G2 C20 C20 B9 B9 B9
T6
B5 B5 B5 M2 M2 B7 B7 B7
W6 W6 W6 W6 W6 W6 W6 W6
C18 C18 C18 C18 T8 T8 T8 T8 T8
T4 T4 T4 T4 T4 T4 T4 T4 T4
C8 C8 C8 C8 C8 I1
H2
C6 M1 M1 M1 M1 M1 C9 C9 C9
V2 V2
J1 J1 J1 J1 J1 I2
P12 P12 P12 P12 P12 P12

W4 W4 W4 W4 W4 W4 W4 W4 C18 H1 H1 H1 H1 T4 T4 T4 T4 T4
T4W2 W2
C8 C8 C8 C8 C8 C9 C9 C9 C9 C9

S12 S12 S12 C20 C20 C20
B5 B5 B5 B5 B5
W3 W3 W3 W3
P12 P12 P12 P12 P12 P12 P12

Site D: Waste from Generation to Generation

M4 W1 M4 W1

M4 W1 M4 R2 M4 W1 R2

M4 R2

M4 R2 C8 C8 C8 C8 C8 C8 C8 C8 C8 C8

M4 C8 C8 C8 C8 C8 W1 W1 W1 M4 R2

C2 A4 A4 A4 A4 A4 A4

C2 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4

C3 F5 F5 F5 F5 F5 F5 F5 C3 V2 V2 V2 V2 V2 V2 V2 V2 V2

V2 V2 V2 C3 B11 B11 B11 B11 B11

F5 F5 F5 F5 F5 F5 F5 F5 F5 F5 V2 V2 V2

V2 V2 V2 V2 V2 V2 V2 V2 V2 S7 S7 S7

K1 K1 K1 C3 F5 F5 F5 F5 F5 F5 F5 F5 F5

K1 K1 K1 K1 K1

V2 V2 V2 V2 V2 V2 V2 V2 V2 S7 S7 S7

R4 R4 B11 B11 B11

T5 R5 R5

S1 R1 R1 R1 R1 R1 R1 R1 R1 R1

L6 L6 L6 L6 L6 L6 L6 L6 L6 L6 L6 L6

N2 N2 N2 N2 N2 B10 B10 B10 B10 B10 B10

C14 C14 C14 C14 C14 C14 14

C14 T3 T3 T3 L2 L2 L2 L6 L6 L6 L6 L6 L6 L6

R1 R1 R1 R1 R1 R1 N2 N2 N2

W5 W5 T5

R1 R1 R1 R1 R1 N2 N2 N2 N2 N2 N2

R2R2R2 D3 D3 C12

C12 C12 C12 C12 G1 G1 G1

L6 L6 L6 L6 L6 L6 L6 L6 M8 M8 M8

T5 C2C2C2C2 C10 C10 C10 C10 C10 P2 P2 P2 P2

A3 A3 A3

A3 A3 A3 L2 L2 L2 A3 A3 A3

C8 C8 C8 C8 C8 N1 N1 N1 S10 N1 N1 N1 N1 N1

L5 S7 S7 S7 S7 S7

M4 M4 M4

M8 P14 L5 P1 P1 P1 P1 P1 P1 A4 A4

A4 A4 A4 A4 A4 A4 C2 W1 W1 W1 W1 W1 W1 W1 W1 W1 W1

W1

C8 C8 C8 C8 C8 M4

M4 M4 M4 M4 W5 W5 W5

B10 B10 B10

D3 D3 D3 D3 H1 H1 N2 N2

R2 R2 R2 R2 R2 C14 C14 C14 C14 P1 P1 P1 P1 P1 P1 P1

Site E: Waste from Generation to Generation

A2 P13 J2 J2 J2 A2 P13

P13 B3

P13 B3 B3

B3 C8 C8 C8 C8 C8 C8 C8 C8 C8 C8

P13 P13 P13 B3

M7 M6 M6 M6 M6 M6 M6

M7 M6 M6 M6 M6 M6 M6 M6 M6 M6 M6 M6 M6

P10 F5 F5 F5 F5 F5 C15 C15 C15 P10 P7 P7 P7 P7 P7 P7

P7 P7 P7 P7 P7 P7 P10 F6 F6 F6 F6 F6

P7 P7 P7 P7 P7 P7 P7

P7 P7 P7 P7 P7 P8 P8 P8

K1 K1 K1 P10 F5 F5 F5 T7 T7 T7

K1 K1 K1 K1 K1 C15 C15

P7 P7 P7 P7 P7 P7 P7 P7 P7 P8 P8 P8

D2 T5

R9 P6 P6 P6 P6 B1 B1 P5 P5 P5 P5

A1 A1 A1 J2 J2 J2 J2 J2

P9 P9 P9 T3 T3 T3

T3 C7 V2 V2

P4 P4 P4 P4 P4

P5 P5 P5 C15 C15 C15 C15

R9

V2 V2 P4 P4 P4 P4 P4

T5 T2 T2 B3 B3 B3

C15 C15 C16 C16 C16 D2 D2 D2

T5 M7 M7 M7 M7 J2 J2 J2 J2 J2

C5 C5 C5 T7 T7 T7

C5 V2 V2 V2 N1 N1 N1 C13

N1 N1 N1 N1 N1

L8 P8 P8 P8 P8 P8

A2 A2

P4 P4 P4 P4 P4 D2

P11

P1 P1 P1 P1 P1 P1 M6 M6 M6 M6 M6 M6

M6 M6 M7 P13 P13 P13 P13 P13 P13 P13 P13

P13 P13 P13

B3 B3 B3 B3 B3 P9 G5 P1 P1 P1 P1

P1 P1 P1

DISCUSSION QUESTIONS

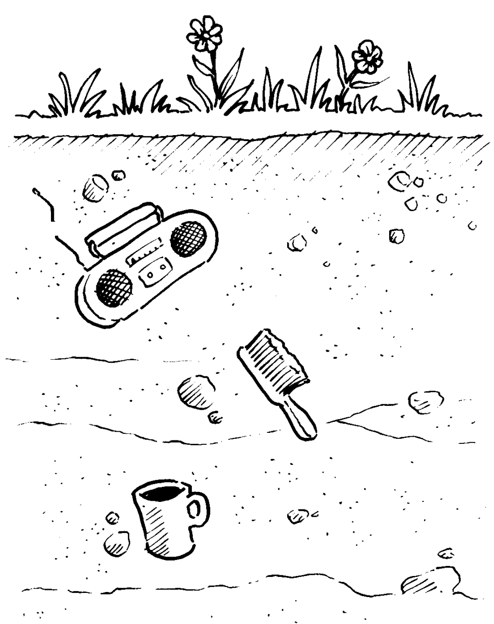
a. Compare the Native American family with today's family. Identify the major differences in waste creation.

b. Did any group of people create less trash than we do today? Why or why not?

c. Is there a commonality between all of the periods? Is there any kind of trash or artifact that did not change?

d. How do you think the advances in materials science have affected lifestyles and subsequently generating trash?

e. What kinds of problems did trash present during the various time periods? How have waste treatment methods changed?



The Archeology of Garbage

One of the best ways to learn about a society is to study its garbage. No one knows more about garbage, both past and present, than Dr. William L. Rathje, Professor of Archaeology at the University of Arizona, and Director of The Garbage Project. Here are a few of the facts that he has gleaned from sorting through landfills.

- Past civilizations and cultures have been just as wasteful as our society. For example, certain Native American tribes routinely killed more bison than they needed to survive. One Plains tribe went so far as to eat only the nose, which they considered a great delicacy. The rest of the carcass was discarded.
- While your parents may be telling you to eat your vegetables, they probably don't take their own advice. Fresh produce is probably the biggest contributor to food waste in garbage.
- People over-report the amount of healthy food they eat, and under-report the amount of not-so-healthy food. The Garbage Project has shown that study respondents say that they eat far more tuna, cottage cheese and lettuce than they actually consume. On the other hand, they drink far more regular soda and beer than they admit.

These actual findings run contrary to what we would like to believe about ourselves and other people. Can you explain why these differences might exist?

Site Report Sheet and Presentation Organizer

INSTRUCTIONS FOR TALLY SHEET

Excavating your site

You are a member of an archaeological team carrying out an excavation. Your team has been assigned a site filled with discards from an unknown time period in American history. Your group should work to identify all the artifacts found on the site. Based upon your findings, try to identify the time period from which they came.

1. Using your site grid sheet which is labeled Waste from Generation to Generation, find an artifact that is represented by a letter and number. Look up the artifact on the Artifact Code Sheet. Write the name of the item on the Tally Sheet.

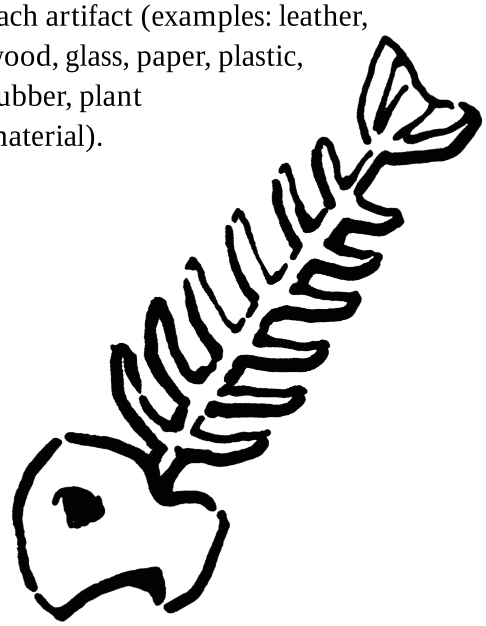
2. Count how many of each artifact you find and add that to your Tally Sheet.

3. Classify each artifact according to its function. For example,

- food
- food preservation/ packaging
- cooking
- tools
- hunting
- clothing
- shelter and "yard"
- amusement
- hygiene and medicine
- transportation

(Not all artifacts will fit within these categories. You may need to assign specific functions to some items.)

4. Identify the materials used to make each artifact (examples: leather, wood, glass, paper, plastic, rubber, plant material).



Tally Sheet

Site Identification

Item Name	Number found	Function	Material
1.			
2.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			

18.

19.

20.

21.

22.

23.

24.

25.

26.

27.

28.

29.

30.

31.

32.

33.

34.

35.

36.

Archaeological Convention

Name ______________________

CLASS PRESENTATION

As part of an archaeological convention, your group will be presenting the findings from your site to the class. In order to have a complete report, answer these questions, using the data table below to organize your notes.

1. In what period did the family live? What were some of the artifacts that helped you to determine the timeframe? What resources would you use to be sure that the time period is correct?

2. Look at the functions of the items on your list. Did this family lead a simple lifestyle or a lifestyle characterized by many conveniences? Why would you say that?

3. How did their lifestyle affect their family's trash?

4. How much and what types of technology did this family enjoy? How did technology affect their trash?

SITE A

1. Time period ______________________

2. Lifestyle ______________________

3. Technology ______________________

4. Effects on trash ______________________

SITE B

1. Time period ______________________

2. Lifestyle ______________________

3. Technology ______________________

4. Effects on trash ______________________

SITE C

1. Time period

2. Lifestyle

3. Technology

4. Effects on trash

SITE D

1. Time period

2. Lifestyle

3. Technology

4. Effects on trash

SITE E

1. Time period

2. Lifestyle

3. Technology

4. Effects on trash

Today's Waste: What's in My Trash?

CONTENT AREAS

- **Social studies**
  population, family structure, geography
- **Science**
  solid waste, data analysis, drawing inferences, supporting conclusions
- **Writing**

OBJECTIVES

Students will...

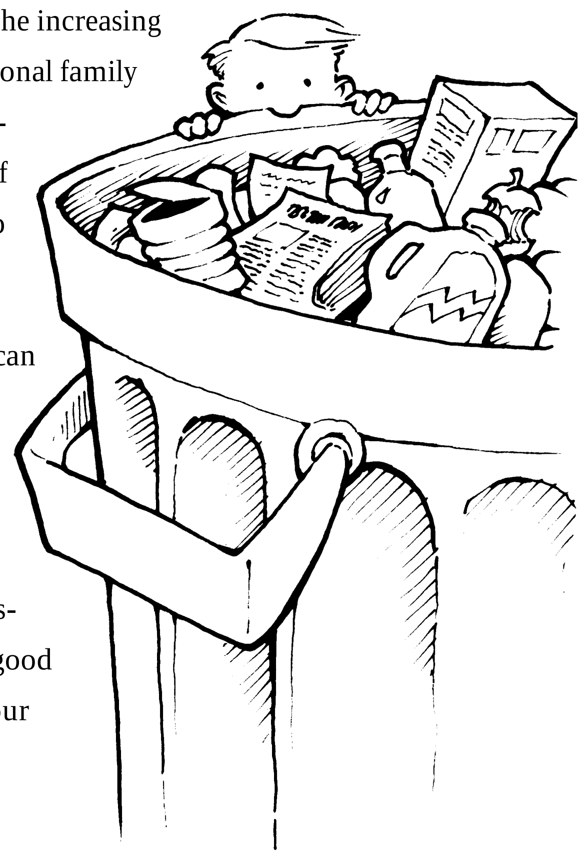
- become aware of the amount and kinds of trash they personally generate in a day
- infer how both the types and amounts of household trash could differ because of family makeup, lifestyle, geography and season

TIME

Two periods
45 minutes each

More waste is being produced per person than ever, although it is leveling off. According to the U.S. Environmental Protection Agency, in 1960 about 2.7 pounds of trash were discarded per person per day. That figure has now grown to 4.3 pounds. Much of the increase is a result of socioeconomic factors. The amount of waste discarded per person can be influenced by size of household, income, degree of urbanization, geographic location, season, number of working adults and other lifestyle factors.

Of note is the change in the American household or family structure over the last 30 years, and the impact it has had on our trash problem. The increasing breakup of the nuclear or traditional family has lead not only to more households but also to a duplication of services, goods and appliances to sustain them.



During this same period, American families increasingly have shifted from one-income to two-income households. This trend has helped to create an increasing reliance on single use and disposable convenience items. For good or bad, convenience is a fact of our current lifestyle.

PROCEDURE

1. As a class, brainstorm a list of possible items that a student could throw into the trash on a typical day, not only at home, but also at school. In generating this list, students should be reminded to think of the different categories of trash: paper, plastics, yard trimmings, metals, rubber/leather, textiles, wood, food, aluminum, glass and "other." A class recorder should compile the list on a word processor or on paper.

2. Duplicate the class list. This will be the Trash Inventory Checklist. Require each student to *monitor his or her discards for one day.* Students should use the list to check off the items they throw away, noting the number of each. Students should also note any discarded items that are not on the list.

3. The day after students complete their inventories, ask them to analyze the results and think about how the data reflects their personal habits and lifestyles. Have each student write an essay that answers this question: "It is 100 years from now and your home is the site of an archeological dig. What would an archaeologist conclude if all of your daily discards were found in a pile?" A possible prompt for students is, "If archaeologists found my trash, they would conclude … about me … because …"

QUESTIONS

Analyze factors that could cause variations between student inventories. Use these questions as prompts for discussion or writing.

a. Would your trash inventory be the same every day of the year? Explain.

b. How would holidays or birthdays affect your trash?

c. Would an archaeologist know what season of the year your trash was from? How?

d. Would most of your neighbors' garbage be similar?

e. Explain how each of the following factors could affect the amount and kinds of household trash:

- a baby or very young children
- a house with a small yard on a city lot
- a house with large lawn in the suburbs
- a rural farm with animals and fields
- a house/apartment with very little storage space
- a family of one parent and one child
- a family of two parents and four children
- a garden to supply vegetables and fruits
- a region that is warm all year
- not having a microwave oven
- having a very large income
- a family with two working parents

e. How does reliance on convenience products seem to affect waste?

EXTENSIONS

1. Ask students to write and share responses to the question: If you were asked to reduce the amount of waste you produce, what would you do and how would it make a difference?

2. Have students look at their inventory sheets and answer these questions: How many bags of trash do you think you produce in a day? In a week? In a year? How big an area would those bags fill? How many bags would everyone in your class produce in a year?

Where Does the Trash Go?

CONTENT AREAS

- **Science**
  energy, by-products, environment, solid waste

OBJECTIVES

Students will…

- become aware of disposal options and their advantages and disadvantages
- recognize the role of energy and by-products in the evaluation of a disposal method
- begin to think about ways to prevent or reduce waste, rather than finding places to put it

MATERIALS

For the class

- notebook paper
- rubber tubing/tire
- wood scrap
- fruit or vegetable peel
- fabric scrap
- battery
- leaf
- empty steel can
- polystyrene foam cup
- plastic bottle
- aluminum foil

For groups of 2 or 3 students

- *Where Does the Trash Go?* handout
- Waste Disposal Chart
  See Key and Teacher's Notes

For groups of 3 or 4 students

- *What's in Our Trash?* Pie Chart Recording Sheet (see Activity 1)

TIME

Two periods
45 minutes each

When it comes to garbage, we tend to treat it as out of sight, out of mind. We set out our trash, someone comes and gets it, and it magically disappears! Unfortunately, it doesn't really go away. It becomes part of the waste stream and travels to its final resting place. There are four basic options for waste: composting, recycling, incineration and landfilling. In this activity, students take a look at these options to understand them better.

At the end of the lesson, we start to discuss waste prevention, or *source reduction.* The idea is for the class to realize that it's better to prevent a problem than to have to figure out how to cope with it or solve it later.

PROCEDURE

1. Give each student a copy of *Where Does the Trash Go?* Ask them to read the handout, which explains recycling, incineration, landfilling and composting. (You might want to do this as a homework assignment the night before the activity.)

2. Select one item of typical garbage, such as a wood scrap. Hold up the item and ask the class what disposal options could be considered for the object. In the case of the wood scrap, it could be incinerated, composted or sent to a landfill.

3. Divide the class into groups of two or three students. Give each group a Waste Disposal Chart to determine what could happen to the wood after it is discarded. For example, wood uses energy when it is sent to the landfill (the trucks use gasoline to take it there), but creates energy when it is incinerated. In the process, it also creates air pollution.

4. Give each group one of the trash items. Note that each item represents a trash category, such as paper, plastic, food waste, yard trimmings and so on. As each group completes its evaluation of the item, it passes it on to another group. Have groups continue trading items until all groups have evaluated all the items. Have students analyze the disposal options for each individual item.

5. Ask students how not using some of these items in the first place would change the amount of materials that end up in the disposal option listed. What types of materials could be reduced, reused or even eliminated? Lead the class into a discussion of reducing the solid waste stream by not using some of the items in the first place or by using items with minimal waste – source reduction.

QUESTIONS

Have the class discuss each of the disposal options and why some methods are preferable to others, depending on the type of waste. Refer to the handout if needed. Clear up any misconceptions concerning the waste types and appropriate disposal of each.

a. Which method of disposal seemed feasible for most items?

b. Which method seemed to use the greatest amount of energy?

c. Which method produced useful by-products?

d. What were some of the harmful effects you noted from the disposal options?

e. Is there any "perfect" disposal option? How would you weigh the benefits against the harmful effects?

EXTENSIONS

1. Examine your community's disposal options. Design a plan to reduce the amount of waste your community must incinerate or landfill. How can each individual help to reduce the waste stream?

Where Does the Trash Go?

COMPOSTING

Composting is the rotting of organic material such as grass trimmings, leaves and food waste into a nutrient-rich material that can be used on gardens as fertilizer or soil enhancer. Yard and food wastes typically account for 20-30 percent of the waste stream. This means there is an opportunity to divert a large part of the waste stream to be composted. Many communities have started or are evaluating setting up a composting facility. Also, many families are setting up composting bins in their backyards and mulching grass clippings from their lawns.

Garbage doesn't decompose very well in landfills because it is tightly packed and covered with soil. To make compost, air, water, heat and soil microbes must be present. Compost piles are turned frequently so these factors will work. Although composting has several advantages, such as producing a useful product and being inexpensive, it also has some disadvantages. Only organic materials can be composted. Also, no one wants to live next to a large compost facility. As compost decomposes, it smells like rotting garbage and is quite unpleasant for those people living close by.

RECYCLING

One very popular way to divert materials from the waste stream is recycling. Recycling is the remanufacture of a material after it's been used. It may be turned into the same thing or something different. Recycling efforts have reduced the amount of material going into landfills. Of course, many waste products are not recycled. The data table shows the percentages of materials that are being recycled and the estimated amount that it is practical to recycle.

Recycling Rates

	Today[1]	Max. Practical[2]
Corrugated boxes	50%	70%
Yard wastes	20	50
Glass bottles and jars	35	40
Office paper	31	50
Steel cans	53	65
Aluminum cans	65	75
Plastic bottles	25	38
All waste	23	33

[1]EPA and various industry sources

[2]Porter and Associates

The important thing on this chart isn't what the recycling rate is now but the maximum practical rate in the future. It isn't practical to collect and recycle everything, especially considering that the reason we recycle: to save resources. If it takes more resources to recycle an item than to produce a new one, the item should not be recycled.

Recycling has become very popular in the past few years. Unfortunately, recycling has frequently grown faster than recycling facilities can handle it, manufacture it into new products, and find markets for the products.

Collecting items for recycling isn't effective if no one is willing to buy the recycled materials and make new products. Unless people are willing to buy the recycled products, companies won't produce them. For example, most plastic bottles are recyclable, yet when was the last time you looked at a bottle to make sure it had recycled content?

Some products, such as paper, cannot be recycled continuously. The wood fiber in paper gets shorter as it goes through the recycling process, and eventually it cannot be further recycled. Some materials may require too much energy to be recycled effectively.

This is especially true if the materials to be recycled are too far away from collection or manufacturing facilities. Does it make sense to ship glass 1,000 miles to be recycled and use more fuel to get it there than is saved by recycling?

The bottom line is that recycling has many advantages. It reduces the amount of garbage going to waste facilities, and in many instances, it can save energy and not create pollutants. But recycling is not a cure-all. It is a process like any other, in that it uses energy, creates its own pollutants and has its own costs. All of these factors must be weighed when deciding how best to reduce waste disposal.

INCINERATION
or Waste to Energy

Modern incinerators burn garbage and nearly all of the plants generate electricity from the heat. An incinerator burns trash such as paper, plastics and broken furniture, turning them into electricity instead of sending them to a landfill. This seems like a better way to make electricity than damming rivers or burning coal or oil. Unfortunately, these plants are very expensive to build and run, and no one wants to live next to them.

Earlier incinerators produced a lot of smoke and pollution. Now, they burn at very high temperatures and have special equipment that eliminates most of the pollution. Incinerators produce ash just like a fireplace does. Typically, the burned trash is reduced to one-tenth its volume and one-fifth its weight. The ash is tested for hazardous materials, and if the hazardous content is too high, it must be disposed of in special landfills. Fortunately, most ash isn't found to be hazardous. By the way, batteries are sometimes listed as hazardous waste that cannot be incinerated and must be sent to expensive toxic waste facilities.

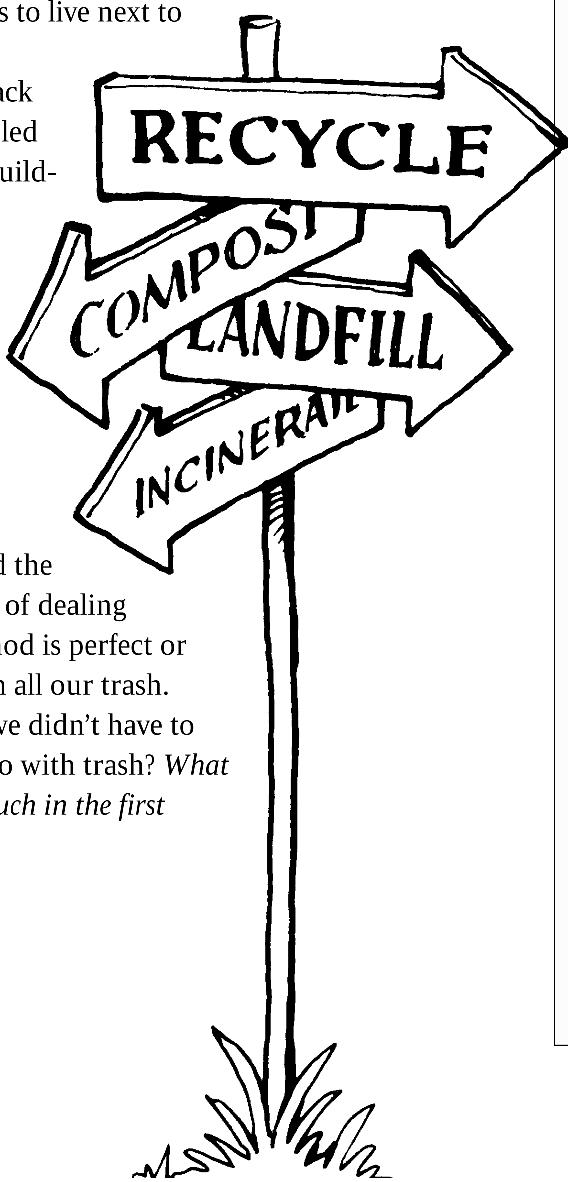
LANDFILLS

A landfill is more than a big hole in the ground. New landfills are designed with special clay and plastic liners to trap liquids, such as rain, which might seep through. Older landfills (often called dumps) had no liners and water and other liquids would soak down through them, sometimes polluting nearby wells and bodies of water.

Regulations now prohibit the disposal of hazardous material in a landfill. When the landfill is filled, it is covered with a membrane and dirt and often turned into a park or golf course.

We often read that we are running out of landfills. For example, we used to have more than 15,000 landfills in the United States; by the year 2,000, only 2,000 are expected to remain. But these numbers do not tell the whole story. Many of the landfills were old, designed improperly and should have been shut down. Also the new landfills that replaced them can be very large. In one case, three regional landfills had a greater capacity than the 500 "dumps" that had been closed. So it's not the number of landfills, but their capacity that's important.

The biggest problem for new landfills is the same as for incinerators and compost facilities–no one wants to live next to one. This is called the NIMBY (Not In My Back Yard) syndrome. Coupled with the high cost of building and maintaining new facilities, the NIMBY syndrome could lead to landfill shortages in some communities in the future.



▪ ▪ ▪ ▪ ▪ ▪ ▪

We've just summarized the four primary methods of dealing with garbage. No method is perfect or capable of dealing with all our trash. Wouldn't it be nice if we didn't have to worry about what to do with trash? *What if we didn't create so much in the first place?*

Strange But True Facts About Waste

Solid waste answers aren't always what we would expect them to be. Here are a few good examples of just how counter-intuitive the facts are:

- Organic materials don't biodegrade in landfills, at least not very quickly. That's because modern landfills are designed to keep out those elements that cause degradation–sunlight, air and water. As a result, the microbes that break down food and paper are not abundant enough to do their jobs. The result? Newspapers and other items can remain intact for up to 50 years!
- It's not always beneficial to recycle glass. A study by Argonne National Labs concludes that if a recycling facility is more than 100 miles from the pickup point, it takes more energy to transport the glass than would be saved by recycling. Why might this be true for glass, but not for other materials?
- Steel recyclers like to be located near incinerators. The reason is that an early step in the incineration process is to use large magnets to pull out magnetic metals before burning. (They don't burn!) Thus, large quantities of recyclable metal are available from one place.
- Speaking of incinerators, strict legislation in various countries has led to vast improvements in their operating efficiency. In one new incinerator in Germany, for example, the air leaving through the stack is said to be cleaner than the air coming in!

Where Does the Trash Go?

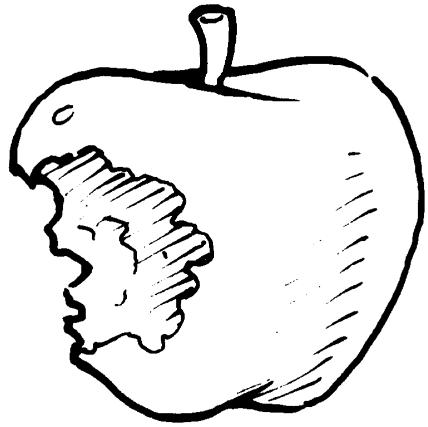
WASTE DISPOSAL CHART

Item	Which method(s) are feasible for this item? (C, R, L, I)*	Do any of these disposal methods use energy?	Do any of these methods create useful energy or by-products?	Do any of these methods create pollution or harmful by-products?
Notebook paper				
Fruit or veg. peel				
Leaf				
Plastic bottle				
Glass jar				
Wood scrap				
Rubber tubing				
Fabric scrap				
Empty steel can				
Aluminum foil				
Foam cup				
Battery				

*** C = Composting**
R = Recycling
L = Landfilling
I = Incineration

Teacher's Notes

FOR WASTE DISPOSAL CHART



The answers to this chart (on the following page) may surprise you and your students. Here's why:

1. With the exception of home composting, all waste disposal methods (recycling, community composting, landfilling and incineration) use energy. Recycling is a process that requires transportation, sorting and manufacturing. Large-scale composting requires transportation and mechanical "turning" of materials. Incineration requires energy to transport material and then begin the burning process. Landfilling requires energy to transport materials to the site, and then to keep the site properly filled, drained, etc.

2. Landfilling is the only method that does not directly create useful by-products. Recycling creates new products, as does composting. Via burning, incineration can create energy by producing steam and electricity. (Indirectly, the methane gas in landfills can also be captured and turned into energy.)

3. All methods create some pollution. Composting gives off methane gas. Transporting materials burns fuel, creating air pollutants. Recycling processes also pollute, as do all manufacturing processes. Incineration creates some pollution as well, along with small quantities of hazardous waste, which must be properly handled, stored and/or landfilled.

4. Note that while batteries are listed as recyclable, recycling is not really economical. (That's expected to change in five to ten years.) Meanwhile, putting batteries into landfills can allow toxic acids and heavy metals to leach into soil and ground water.

5. Rubber tubing or tires can be ground up and used as filler in asphalt.

6. Wood scraps can be recycled into pressed-board or ground up for use in fireplace logs.

7. Fabric scraps are of limited recycling value. They can be reused, however, as rags or replacements for paper towels.

8. Foam cups can be recycled, although facilities for this are limited.

Answer Key: Where Does the Trash Go?

WASTE DISPOSAL CHART

Item	Which method(s) are feasible for this item? (C, R, L, I)*	Do any of these disposal methods use energy?	Do any of these methods create useful energy or by-products?	Do any of these methods create pollution or harmful by-products?
Notebook paper	C, R, L, I	C, R, L, I	C, I	R, L, I
Fruit or veg. peel	C, L	C, L	C	L
Leaf	C, L	C, L	C	L
Plastic bottle	R, L, I	R, L, I	R, I	R, L, I
Glass jar	R, L	R, L	R	R, L
Wood scrap	C, R, L, I	C, R, L, I	C, R, I	R, L, I
Rubber tubing	R, L, I	R, L, I	R, I	R, L, I
Fabric scrap	L, I	L, I	I	L, I
Empty steel can	R, L	R, L	R	R, L
Aluminum foil	R, L	R, L	R	R, L
Foam cup	R, L, I	R, L, I	R, I	R, L, I
Battery	R, L**	R, L	R	R, L

*** C = Composting**
R = Recycling
L = Landfilling
I = Incineration

***Not recommended, but may be the only option*

Island Survival

CONTENT AREAS

- **Math**
  estimating, adding
- **Science**
  natural resources, adaptations, solid waste
- **Health**
  nutrition

OBJECTIVES

Students will…

- develop a working definition of source reduction by employing their own source reduction strategies
- recognize source reduction as an effective means of controlling solid waste
- make decisions based on wants versus needs

MATERIALS

For groups of three students

- Island Survival Sheet and Item List
- calculator (optional)

TIME

Three periods
45 minutes each

Source reduction can be defined as a *collection of activities and actions that lead to a reduction in the quantity and/or toxicity of solid waste.* Simply said, it is a process of using less material and energy. In this simulation, students will make lifestyle choices while considering the effects of these choices on the amount of waste generated. By making careful choices, students will be practicing source reduction strategies that can carry over into real life.

This activity works well as an introduction to source reduction. Through participation in the simulation, students will develop their own working definition of source reduction before actually being introduced to the concept.

PROCEDURE

1. Have students form groups of three. In case not all groups have three, have students create an "imaginary" partner.

Read the following scenario to the class:

You will be traveling to the island of Etsawon (backward spelling of no waste). You will spend two weeks on this uninhabited island with two friends. The island is mostly wooded with a small sandy beach on the south side. There is no food, but fresh water and wood are plentiful. The temperature at this time of year is mild, but occasionally you may experience some cool nights. Rain is always a possibility. There are no man-made shelters, except for an out-house. There are no disposal options, such as land-fills, recycling plants or incinerators for your waste. You must bring back all your waste.

You will be taken to the island by boat. Your group will be allowed to bring a maximum of 90 lbs. of supplies. A smaller boat will take you home on the return trip. Your group will be able to return with only 45 pounds of supplies and waste materials. You must leave the island as you found it. Do not leave any of your supplies, belongings or trash behind–and not buried in a hole, either.

Your group must work together to prioritize your personal needs, desires, essentials, etc. Together, compose a list of what each individual will bring for himself or herself and the group. Remember–you must stay within the group weight limit. Good luck!

Teacher's Note: Remind students that they need to plan for 42 breakfasts, lunches and dinners. You may need to check lists to make sure they bring enough food.

2. Students brainstorm a list of items they might need for the trip and then prioritize the list. Students must have items in each of the following categories:

- Food (minimum three meals per day)
- Shelter
- Clothing (minimum five pounds per person)
- Health
- Recreation and entertainment
- Grooming

In addition, each group must have a first aid kit and a portable light source.

3. Distribute one copy of the Island Survival Sheet and the Item List to each group. The latter is a list of items students may take to the island. Each item is followed by two measurements: the weight of the item and the weight of waste it generates. Each group is responsible for their calculations. They must be prepared to present their lists and calculations, and to defend their choices.

4. After students make their decisions, have each group answer the following questions together. Then, as a class, discuss how the various groups answered these questions.

Questions

After the presentations, lead students in a discussion that addresses the following:

a. Discuss how your decisions were made. (As a group, as individuals, etc.)

b. Relate these decisions to those made in real life (with family and friends).

c. Why don't we make the same choices in our everyday lives? (We don't seem to have the same restrictions – or do we?)

d. How did you decide what type of product is best in terms of the least amount of waste generated? (Weight? Number of uses? Types of uses?)

e. Is it always better to use less? Are there times when it makes sense to use more? (Does using less always translate to more efficiency?)

f. What about products shared by the group as opposed to individual products?

g. How frequently did your group employ sharing strategies?

h. How might group strategies apply to real life?

i. What individual sacrifices had to be made for the good of the group?

j. What was your best weight-saving strategy?

k. Did any items have a dual function?

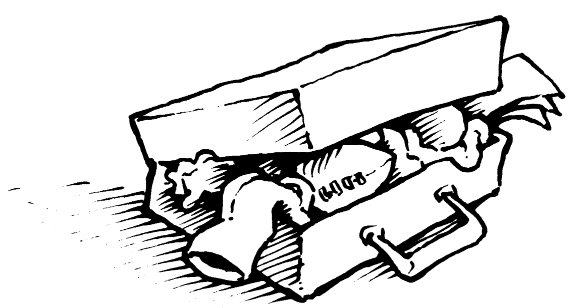
5. Introduce source reduction and ask the class to attempt to make a working definition. Define source reduction for the class :

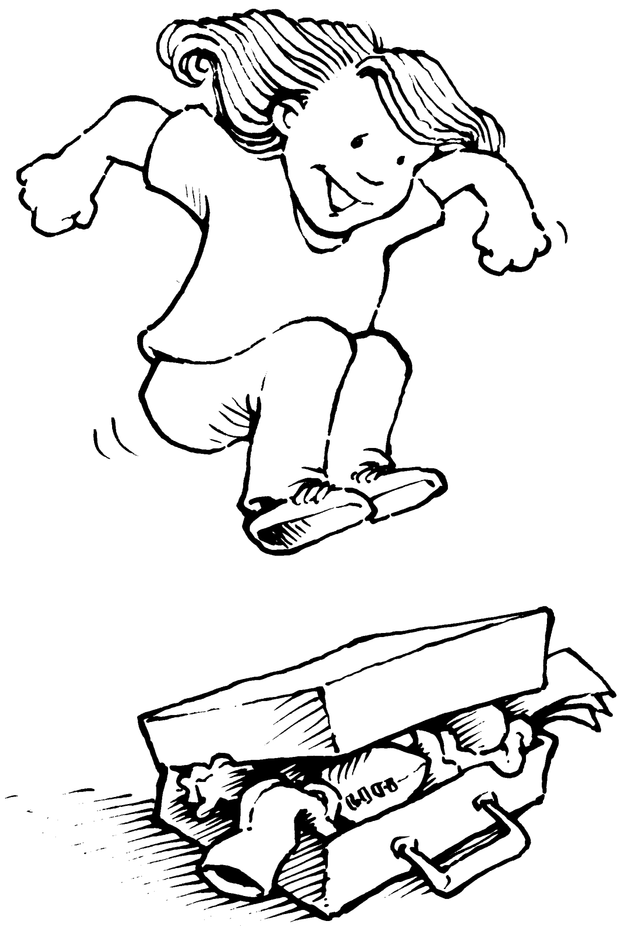
Source reduction is the collection of activities and actions that lead to a reduction in the quantity and/or toxicity of solid waste. Simply said, it is a process of using less material.

6. Discuss how source reduction strategies were used in the simulation in place of other disposal options. Draw inferences from what students did on the island to real life applications. Talk about source reduction strategies that could be used in real life such as bulk purchasing for a group, sharing magazine subscriptions, reusing containers, buying concentrates or larger sizes, using rechargeable batteries, using both sides of the paper, pooling cars, etc. Discuss the importance of source reduction as the most effective way to cut down on waste.

7. Ask the class where the name Etsawon came from.

8. Have the class think about the island as a metaphor for the Earth. What does this say about the way we need to live our everyday lives? (This is a great essay topic!)





EXTENSIONS

1. Contact NASA and obtain information on how source reduction is used on the Space Shuttle. How are necessary items packaged to minimize waste? What types of choices must be made for the benefit of the crew as opposed to the individual? For NASA information, please contact:

   NASA
   Educational Affairs Division
   Washington, DC 20546

   For information on NASA's Spacelink, an electronic information service that allows individuals to leave messages for NASA scientists, contact:

   Spacelink Administrator
   NASA Marshall Space Flight Center
   Mail Code CA20
   MSFC, AL 35812

2. National parks and some state parks have a carry in/carry out policy. How does this affect what you pack for a picnic or for a camping trip?

3. Do you have food cooperatives or bulk buying programs in your community? How does this method of consumer buying cut down on waste?

Island Survival Sheet

You will be traveling to the island of Etsawon. You will spend two weeks on this uninhabited island with two other friends. The island is mostly wooded with a small sandy beach on the south side. There is no food, but fresh water and wood are plentiful. The temperature at this time of year is mild, but occasionally you may experience some cool nights. Rain is always a possibility. There are no manmade shelters, except for an out-house. There are no disposal options such as landfills, recycling plants or incinerators for your waste. You must bring back all your waste.

You will be taken to the island by boat. Your group will be allowed to bring a maximum of 90 lbs of supplies. A smaller boat will take you home on the return trip. Your group will be able to return with only 45 pounds of supplies and waste materials. You must leave the island as you found it. Do not leave any of your supplies, belongings or trash behind.

Your group must work together to prioritize your personal needs, desires, essentials, etc. Each person must bring along at least five pounds of clothing. You must also have enough food to ensure three meals a day for two weeks (14 breakfasts, 14 lunches and 14 dinners for each person, or 42 breakfasts, 42 lunches and 42 dinners for your group). You must also bring one first aid manual and kit and a portable light source for the group.

Together, compose a list of what each individual will bring for himself or herself and the group. Remember–you must stay within the group weight limit. Good luck!

Item List

Note: Some of the items listed are followed by two weights. The first is the total weight of container and contents. The second is the empty container.

FOOD

peanut butter in a glass jar (28.2 oz., 10.2 oz.)

peanut butter in a plastic jar (19.7 oz., 1.7 oz.)

bottled juice –1 gallon (7 lb. 8 oz.)

8 oz juice boxes – (8 oz., .6 oz.)

popcorn, unpopped (16.4 oz., .4 oz.)

popcorn, popped (16 oz., .4 oz.)

soft drinks in 16 oz cans (18 oz., 2 oz.)

powdered drink concentrate (16 oz., 3 oz.), makes 64 oz.

5 lbs fresh oranges (4 lbs., 1 lb.)

5 lbs fresh apples (4.5 lbs., 8 oz.)

dried apples (8 oz., .4 oz.)

5 lbs fresh grapes (4.8 lbs., .3 oz.)

raisins (8 oz., 1 oz.)

10 lbs fresh potatoes (10 lbs., 4 oz.)

instant potatoes

canned vegetables (16 oz., 3 oz.)

canned fruit (16 oz., 3 oz.)

freeze dried vegetables (8 oz., .4 oz.)

bread (16 oz., .5 oz.)

cereal (16 oz., 3 oz.)

crackers (10.5 oz., 1.5 oz.)

Ramen noodles (3 oz., .5 oz.)

individual servings of cereal (3 oz., .5 oz.)

dried milk (16 oz., 2 oz.)

fresh milk (3 lbs., 3 oz.)

dried soup mix (14 oz., 1 oz.)

canned soup (10.5 oz., 3 oz.)

macaroni and cheese in a box (10 oz., 1.5 oz.)

package of macaroni (16 oz., 1 oz.)

cheese (1 lb., .5 oz.)

canned spaghetti (16 oz., 3 oz.)

dried spaghetti (16 oz., .5 oz.)

spaghetti sauce in a jar (1 lb., 5 oz.)

dozen eggs (1 lb.)

canned tuna (8 oz., 2 oz.)

squeeze bottle of jelly (12 oz., 1 oz.)

jar of jelly (12 oz., 7 oz.)

pretzels (16 oz., .3 oz.)

baked beans in a can (16 oz., 2 oz.)

frankfurters (1 lb., 1 oz.)

candy in a bag (8 oz., .5 oz.)

candy in a box (16 oz., 3 oz.)

gum (1 oz., .5 oz.)

lollipops (16 oz., .5 oz.)

C L O T H I N G

underwear (3 oz.)

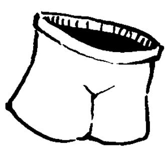
T-shirts (5 oz.)

flannel shirts (10 oz.)

sweaters (14 oz.)

sweatshirt (1 lb.)

jeans (1 lb.)



shorts (10 oz.)

socks (3 oz.)

jacket (2 lbs.)

raincoat (3 lbs.)

sneakers (2 lbs.)

hiking boots (3 lbs.)

rain boots (2 lbs.)

swimsuit (10 oz.)

hat (6 oz)

S H E L T E R

tent (3 lbs.) - sleeps 3

sleeping bag (2 lbs.)

mosquito netting (8 oz.)

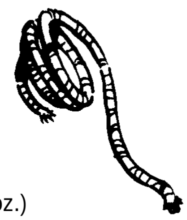
blanket (2 lbs.)

pillow (12 oz.)

plastic tarp (1.5 lbs.)

inflatable mattress (2 lbs.)

rope (6 oz.)



H E A L T H

first aid kit (10 oz.)

first aid manual (4 oz.)

diarrhea medication (8 oz.)

vitamins (4 oz.)

G R O O M I N G

toilet paper (4 oz./roll)

brush (5 oz.)

sunscreen (10 oz.)

shampoo (tube concentrate) (8 oz.)

shampoo- plastic bottle (14 oz.)

bar soap (4 oz.)

liquid soap (6 oz.)

pump toothpaste (5 oz.)

can of deodorant (7 oz.)

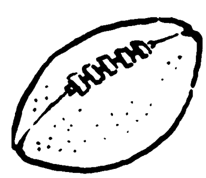
roll-on deodorant (3 oz.)

razor (1 oz.)

R E C R E A T I O N /
E N T E R T A I N M E N T

cards (4 oz.)

football (10 oz.)



Frisbee (3 oz.)

cassette tapes (2 oz.)

CDs (2 oz.)

boom box (4 lbs.– 4 batteries)

hardback books (14 oz.)

paperbacks (5 oz.)

Gameboy (6 oz.)

batteries (4 oz. each)

O T H E R

paper towels (6 oz./roll)

dishes (3 oz. each)

pans (1.5 lbs.)

small gas stove (3 lbs.)

matches (1 oz.)

propane gas cartridge (1 lb., 5 oz.)

charcoal (4 lbs., burnable bag)

flashlight (8 oz. + 2 batteries)

metal forks and spoons (2 oz each)

compass (4 oz.)

candles (2 oz.)

knife (4 oz.)

fishing pole (1 lb.)

fishing tackle (6 oz.)

bucket (1 lb.)

plastic garbage bags (1 oz.)

shovels (4 lbs.)

folding cot (8 lbs.)

flares (3 oz. each)

cooler (2 lbs.)

short-wave radio (2 lbs.)

camera (1 lb.)

film (4 oz)

lighter (3 oz.)

flint (1 oz.)

island map (2 oz.)

field guide (3 oz.)

notebook (10 oz.)

pen (2 oz.)

Physical Properties of a Package

CONTENT AREA

- **Science**
  measurement, physical properties

OBJECTIVES

Students will…

- test the physical properties of packaging materials
- determine appropriateness of packaging materials for commonly purchased items

MATERIALS

For each student

- Station Instructions
- Properties of a Package data tables

For the stations

- 2 triple beam balances or digital scales
- 5 beakers
- tape
- glue
- food coloring (blue or green)
- 2 spoons
- paper towels
- 2 micrometers
- assorted gram weights (1, 5, 10, 20, 50, 100 and 1000 grams)
- paper packaging materials (candy wrappers, brown and/or white paper bag, tissue paper, lightweight cardboard boxes, such as cereal or cracker boxes; shoe boxes, pieces of appliance boxes)
- plastic packaging materials (polystyrene foam cup, clear wrap, such as Saran® brand wrap; plastic bottles, yogurt containers, bread wrappers)
- metal packaging materials (aluminum foil, aluminum cans, tin cans)
- composite packaging materials (coated milk cartons from the cafeteria or home, coffee bags, pet food or snack wrappers, juice boxes, foil/plastic drink pouches)

Safety Caution:
Do not use glass–there is the possibility of breaking or splintering.

TIME

Three periods
45 minutes each

In designing a package for a product, one must take into account the physical properties of various materials. Some products can be packaged in lightweight, flexible containers, while fragile items require heavier and usually more rigid packaging. Liquid products need containers that don't leak or easily spill. With food, one must also ensure that what's inside the package remains fresh and edible until consumed. And all packages must withstand the trip from producer to warehouse to store to consumer.

This activity asks students to collect and test a variety of packaging materials. As students rotate through a series of stations set up in the classroom, they perform various tests for mass, permeability, and "writability." The more tests that students perform, the better understanding they will have of the fact that packaging is scientifically designed for the product it houses.

The end result should be that students begin to realize just how complex packaging decisions can be. They should also become aware of the importance of designing packages with source reduction in mind, and that today's designers work hard to be as efficient as possible.

PREPARATION

1. Ask students to bring in samples of packaging materials that they have at home, so you don't have to collect them all yourself. (To ensure that you have all types represented, you might want to use the list on the previous page and ask for specific items.)

   Although the tests being performed are fairly rudimentary, they should give students a sense of the various aspects of a package. Because of this, all 24 pieces of each type of packaging material need not be identical, but similar– i.e., cereal boxes, yogurt containers, foils, juice boxes. Set aside a few containers, cans and wrappers for stations 3 and 4.

2. Set up three stations in your classroom – each large enough to allow groups of four to six students to work comfortably. At each station, place an Instruction Sheet and materials as described below.

STATION 1

Mass, Volume & Density

Materials

Two triple beam balances or digital scales; ruler; micrometer; enough pieces of test materials so that four students at a time can determine the mass of the various packaging materials.

Instruction card

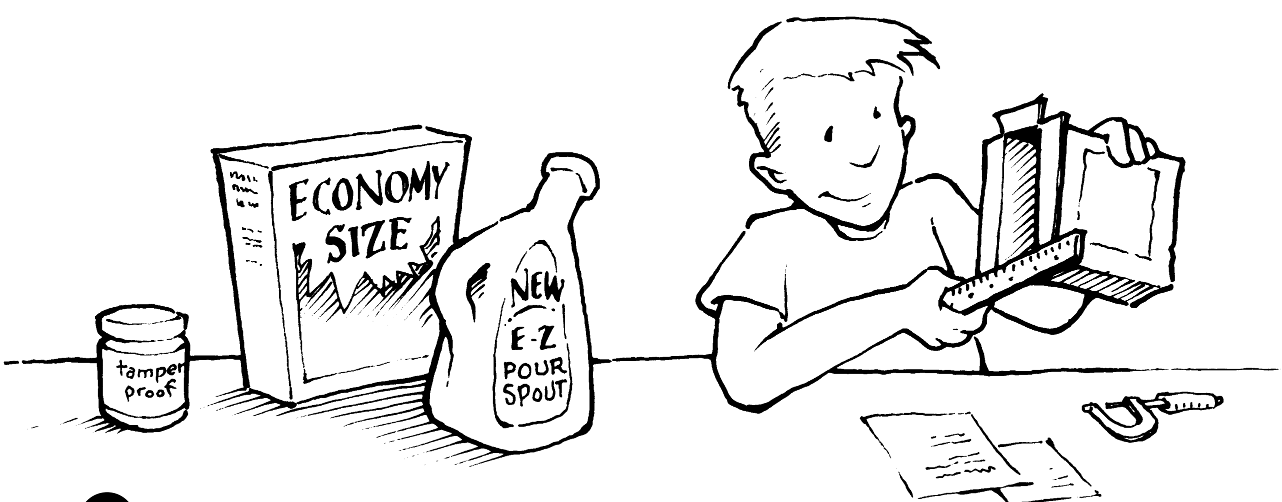
For each packaging material, calculate mass and record your findings. To determine the mass, weigh items on the triple beam balance or digital scale. To determine volume, refer to Activity 1 and remind the class of the equation:

Volume = Length x width x height

(Students may need to use the micrometer to measure width, which in many cases is the same as thickness.)

Density is the amount of mass per unit of volume. Once students have determined mass and volume, they can calculate density using the following equation:

Density (D) = mass (m) ÷ volume (v)



STATION 2

Leakage

Materials

Five empty beakers; small bucket or pan;
1 beaker filled with water colored with several drops of food coloring; packaging materials similar to those at stations 1 and 2, but in the form of pouches, cups, cans or other small containers. (For flat, flexible materials, create pouches of the packaging material. Use tape or glue if necessary. For plastic foam and cardboard, use cups. For more rigid materials, use containers made of that material–for example aluminum cans, yogurt containers, juice boxes.)

Instruction card

1. Pour 25 ml of colored water into each pouch or container while it is over a pan, bucket or sink.
2. Continue to hold the pouch or container over a beaker for three or four minutes.
3. Observe the various packaging materials. Does the material allow the colored water to leak? If so how much? Note your observations.
4. Empty the colored water into the bucket or pan.

STATION 3

Special Features

Materials

Coffee bags, cheese wrappers, juice boxes, plastic bags, chip bags, soda cans, vegetable cans, milk cartons, dish detergent bottles or boxes

Instruction card

Observe and record the following features:

1. *Layers.* Is there more than one layer of material? If so, are the layers of the same material?
2. *Recycle numbers.* Look on the bottom of plastic containers. Often there is a number within a triangle. What are the numbers? What do they mean?

3. *"Scrunchability"* (compaction). Try to scrunch or compact the material. How easily does it compact? Does it stay that way?

4. *Protective features.* Note any features that protect the product from tampering, spoilage or damage.

5. *Flexibility.* Try to bend or fold the material. How flexible is it? Can the material withstand repeated folding and bending?

6. *Writability.* Use a Sharpie felt pen to determine how easy it is to write on the material.

PROCEDURE

1. Introduce the lesson by asking students "How do we define matter?" (Anything that takes up space and has mass.) What are the physical properties used to identify matter? (Color, composition, elasticity, density, mass, volume) Explain to students that they will determine and test various characteristics of packaging materials.

2. Give each student or group a copy of the data table.

3. Familiarize students with the various stations and the tests they will be performing.

4. Divide the class into 5 or 6 groups and have each group work at a table, with the members taking turns testing the various items at the table and recording the results. As students rotate through the various stations, they conduct different tests of the packaging materials. It should take 15 minutes at each station for students to conduct the test and record the data on their data table.

5. Be available to answer any questions or assist with testing.

QUESTIONS

When all students/groups have completed the tests, conduct a class discussion on appropriate product packaging based on their findings.

a. You might begin the discussion by presenting a really ridiculous idea: Why don't we buy pickles in cardboard boxes? Or computers in aluminum foil? Or candy bars in tissue paper?

b. What are the packaging factors that make products available whenever we want them in stores? Why is packaging needed?

c. What factors contribute to selecting appropriate materials for certain products? Besides the ones tested, what other physical properties might packages need to have? (Strength, impact resistance, weather resistance, hardness, etc.)

d. What other types of tests might be done before a package can be placed on a store shelf?

e. How does the definition of "appropriateness" change when looking at the various physical properties from a source reduction or waste standpoint? Is a material that is "appropriate" for packaging necessarily "appropriate" in environmental terms?

f. Describe the physical properties of the "perfect" packaging material.

EXTENSIONS

1. Place a piece of the same kind of cheese in several types of clear wrap. (One of these must be Saran® Wrap.) Design a way to test the type of package that keeps cheese from getting moldy. Test different amounts of the same packaging material and see if it makes a difference in the protection of the product.

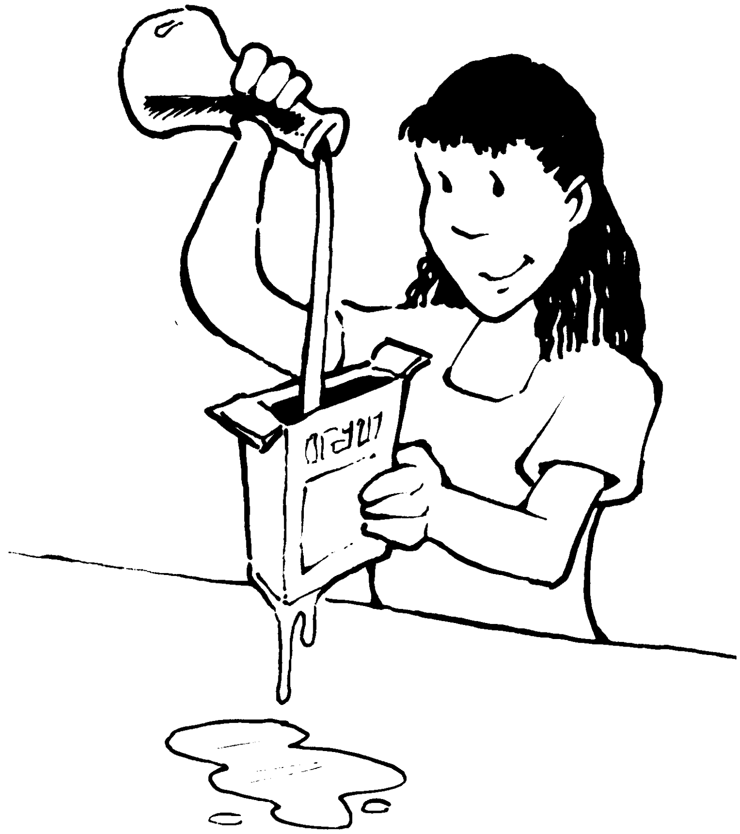
2. Go to the library and research the history of packaging and how materials have changed.

What Else Does Packaging Do?

Many products are packaged in a way that makes them easy to use. For example,

- *Squeezable bottles get ketchup flowing faster, then keep it from overflowing.*
- *Airtight packaging ensures that medical items, such as bandages and surgical instruments, stay sterile until used.*
- *Paper milk cartons have tops that make them easy to open, close and pour. Plastic milk containers have handles that make them easy to hold and carry.*
- *Spice containers have closures or lids that make it simple to pour or measure the right amount of flavoring.*
- *Cereal boxes have reclosable tops that keep contents fresh.*
- *Bottles with pop-up tops permit shampooing without removing the cap.*

Packages also provide important information about their contents. Food packages contain preparation instructions as well as nutritional, dietary and ingredient data. Packages of all types include safety and storage information.



Station Instructions

Station 1: Mass, Volume & Density

1. For each packaging material, calculate mass and record your findings. To determine the mass, weigh items on the triple beam balance or digital scale.

2. Calculate the volume of each material, using the formula we used in Activity 1:

Volume = Length x width x height. You might need to use the micrometer to measure width, or thickness.

3. Density is the amount of mass per unit of volume. Calculate the density of each of the materials.

Station 2: Leakage

1. Pour 25 ml of colored water into each pouch or container. (Do this over a sink, pan or bucket.)

2. Once filled, hold the pouch or container over a beaker for three to four minutes.

3. Observe the various packaging materials. Does the material allow the colored water to leak? If so, how much? Note your observations.

4. Empty the colored water into the bucket or pan.

Station 3: Special Features

Observe and record the following features:

1. *Layers.* Is there more than one layer of material? If so, are the layers of the same material?

2. *Recycle numbers.* Look on the bottom of plastic containers. Often there is a number within a triangle. What is the number?

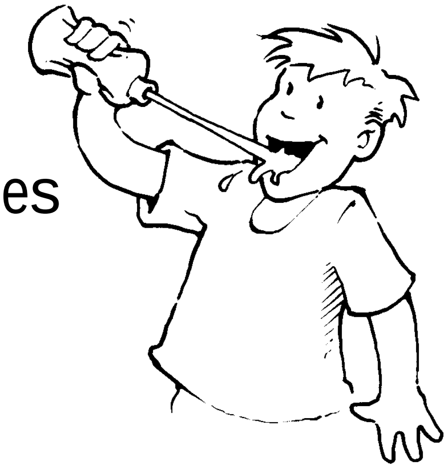
3. *"Scrunchability"* (compaction). Try to scrunch or compact the material. How easily does it compact? Does it stay that way?

4. *Protective features.* Note any features that protect the product from tampering, spoilage or damage.

5. *Flexibility.* Try to bend or fold the material. How flexible is it? Can the material withstand repeated folding and bending?

6. *Writability.* Use a Sharpie felt pen to determine how easy it is to write on the material.

Properties of a Package Data Tables



Station 1: Mass, Volume & Density

Material	Density	=	Mass	÷	Volume
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Station 2: Leakage

Material	Yes / How Much	No
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Properties of a Package Data Tables

Station 3: Special Features

Material	Layers	Recycle#	Scrunchability
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Station 3: Special Features, continued

Material	Protective features	Flexibility	Writability
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

A Juicy Investigation

CONTENT AREAS

- **Math**
  volume, weight, ratios

OBJECTIVES

Students will…

- gain an understanding of the waste generated by various packaging that is commonly used
- calculate the ratio of packaging weight versus actual product
- use the recycling rate to determine the amount of packaging that might go to a waste facility
- project amounts of waste generated over a period of time
- think of other factors that should be considered in packaging
- support a position statement

MATERIALS

Per groups of three or four students

- calculator
- balance that measures in ounces (or a conversion chart)
- Orange Juice Packaging Analysis Worksheet
- 64 or 46 oz. orange juice can
- 6 oz. orange juice can
- paperboard can of frozen orange juice concentrate
- juice box (aseptic package)
- aseptic package (juice box) of juice concentrate
- 64 oz. coated paper orange juice carton
- glass orange juice jar
- 2 plastic jugs (#2 HDPE colored, #2 HDPE uncolored)
- minisip juice pouches with outer paperboard box (if available in your area)
- 10 oranges with juice removed and the peel, pulp, and seeds in a plastic bag

(Retain the juice and measure its volume in fluid ounces for use in calculations.)

Note: *All containers must be empty. Also, it is more important to have a variety of juice containers than to have all orange juice containers. Any fruit juice will do.*

TIME

Two periods
45 minutes each

On a daily basis, we use products that have been packaged–cereal in boxes, toothpaste in tubes, vegetables in cans, shampoo in plastic bottles. In this activity, students investigate one product they are likely to encounter in the morning before they leave for school–orange juice. Even in its natural state, it comes "packaged". This activity allows students to calculate the amount of product they get for each ounce of packaging material. From their information, students see how packaging can be measured, how widely packaging varies in familiar products such as orange juice and hopefully, how they can make more informed purchasing decisions.

PROCEDURE

1. As part of a discussion or writing activity, ask students to list as many types of packaging as they can think of for orange juice or other types of fruit juice.

2. Tell students they are going to compare many of these types of packaging to see which contributes most to solid waste. Ask, "What would be a fair way to compare each of these packages?" Lead students to the idea of finding out how much juice is delivered for each ounce of packaging. (It's not fair just to weigh the package, since different containers deliver different amounts of juice.)

3. Divide the class into groups of three or four students each. Give each group at least one or two containers. Although you may not have all the juice containers, it is important that you have the common ones: paperboard cartons, plastic jugs, paperboard frozen concentrate cans, juice boxes and fresh oranges. If you don't have all the containers, obtain a few of each kind so groups can work without waiting.

4. Give each group a copy of the student worksheet. Ask students to write down a hypothesis about which container provides the most orange juice for each ounce of container. Point out that an ounce is a measure of weight–a fluid ounce is a measure of volume. For this activity, students will compare fluid ounces of orange juice (volume) to ounces of packaging (weight).

5. Tell students to follow the instructions on the worksheet as they weigh the various containers, make their calculations and record data. Be available to answer questions and solve problems as students complete their worksheet data tables.

To help things along, you might want to make an overhead of the Student Handout on page 70 and walk your students through an example.

QUESTIONS

When students have completed their worksheets, have them answer the following questions in writing or discussion:

a. Which product provides the most juice for the least packaging?

b. How does this change when recycling rates are considered?

c. What are other waste and energy factors that should be considered when evaluating these products?(Consider factors such as refrigeration and freezing, energy needed to process various juices, shipping, amount of shipping packaging, size of product.)

d. Which packaging would you choose? Support your answer with evidence.

e. Were your hypotheses concerning orange juice containers correct?

EXTENSIONS

1. Construct a bar graph showing the amount of orange juice provided by each ounce of packaging. This is the information in Column D of Data Table 1. Students could also construct a bar graph that shows the amount of waste for each type of container. This information is found in Column E of Data Table 2.

2. Name other goods that come packaged in many different ways, such as laundry detergent. Do an analysis similar to the one you did for orange juice and present your findings to the class.

3. Some packaging is unpopular with consumers, even though it's the best choice in terms of source reduction. What are some products this may be true about, and what may be some of the reasons consumers choose them?

4. Research the history of water packaging. Since prehistoric times, humans have needed to carry and store water. Carrying water allowed hunters, farmers and nomads to venture away from water sources. How has water storage evolved? How is it stored and delivered in your community? Do you get water from a reservoir or well? What form does packaged water come in your area?

5. Determine the cost of juice delivered per ounce of packaging. Are the most efficient packages the best sellers? What does this tell you about the value of convenience to most people?

DID YOU KNOW?

Students may think that fresh orange juice would be the best choice overall. They may be interested to know that if the 9.3 million tons of citrus fruit produced in Florida were shipped fresh to consumers, 4.8 million tons of waste would need to be disposed of by sanitation workers. Instead, only about 1 million tons is produced. The parts of the fruit that can't be eaten stay in Florida, where they are made into animal feed and other by-products.[1]

REFERENCE

1. Kelsey, Robert, *Packaging in Today's Society,* Lancaster: Technomonic Publishing Company, 1989, p.32.

Teacher's Notes

Here are reference numbers for various packaging types. You'll note that concentrates are by far the most efficient way to package juice, followed by HDPE (#2) plastic and paper cartons. Glass is relatively inefficient, and 10 fresh oranges are the most inefficient of all!

Juice Packaging Comparison

	Fl. oz. of Juice	Oz. of Packaging	Fl.oz.of juice/ Oz. of Packaging	% Product to % Packaging*
Paper carton	64.0	2.3	27.8	97/3
Glass bottle	32.0	15.7	2.0	67/33
Steel can	46.0	5.7	8.1	89/11
Juice box	8.5	0.4	21.3	95/5
Half-gallon HDPE bottle	64.0	1.7	37.6	97/3
Mini-sip pouches/box (Capri-Sun)	67.8	6.7	10.1	91/9
Concentrate (juice box)	46.0	0.5	92.0	99/1
Concentrate (frozen, paperboard)	48.0	1.1	43.6	98/2
10 oranges	27.0	41 .0	0.7	40/60

**Numbers are approximate, because the weight of different juices will affect the ratio.*

Orange Juice Packaging Analysis Worksheet

Data Table 1

A Package or Product	B Pkg. Wt. in Oz.	C Juice*Amount in Fluid Oz.	D Fluid Oz. of Juice per Oz. of Pkg.	E Wt. per Gal. of Juice (128 x D)	F Wt. per 100 Gal. in Oz. (E x 100)	G Pkg. Wt. per 100 Gal. in Lbs. (F/16)

**For concentrates, use ready to drink (reconstituted) fluid ounces.*

Data Table 2

A Package or Product	B Recycle Rate (%)	C Pkg. Wt. per 100 gal. in lbs.	D Amount Recycled in lbs. (BxC)	E Amount of Waste to Waste Facility in lbs. (C-D)

Orange Juice Packaging Analysis Worksheet

DIRECTIONS

1. Develop a hypothesis about which container provides the most orange juice for the least amount of packaging weight.

____

____

____

____

____

____

2. Now make a hypothesis about which container, after recycling, contributes most to the solid waste problem.

____

____

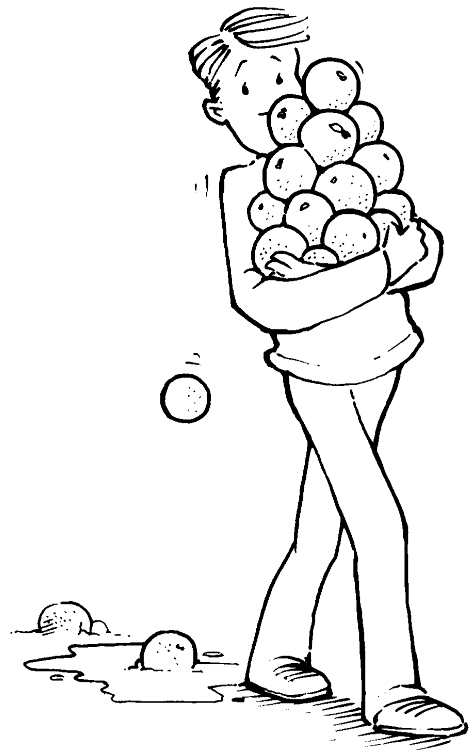
____

____

____

____

3. For each juice container, starting with the one that has been given to you, work as a group to complete the following calculations and record the information in Data Table 1. Remember: In this activity, you are comparing fluid ounces of orange juice (volume) to ounces of packaging (weight).



DATA TABLE 1

Here's a guide to the information needed in each column of Data Table 1:

Column A: Note the type of package you are examining.

Column B: Weigh the package on the scale. Note how many ounces it weighs.

Column C: Note the number of fluid ounces of juice the package contains or provides. For the concentrate can, note the amount of juice the concentrate makes when water is added, not the amount of concentrate in the package. Return the package.

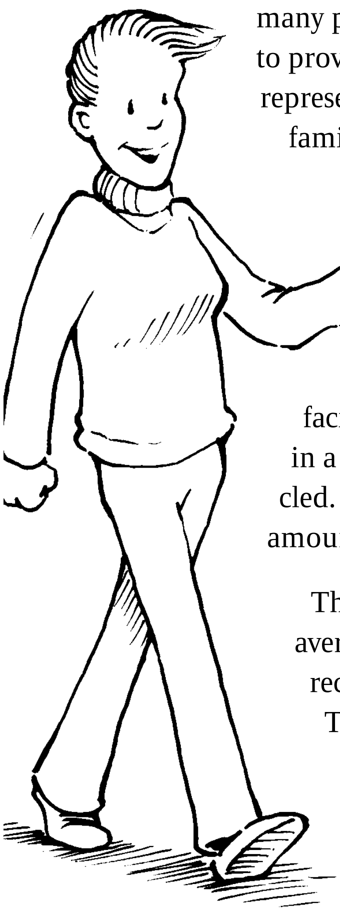
Column D: Calculate how many fluid ounces of juice are provided for each ounce of packaging. Divide the number of fluid ounces provided (answer in Column C) by the weight of the package (answer in Column B).

Column E: Calculate what the weight of this type of packaging would be if you needed one gallon of juice. Multiply the answer in Column D by 128 (1 gallon = 128 fluid ounces).

Column F: Calculate what the weight of this type of package would be if you needed 100 gallons of juice. Multiply the answer in Column E by 100.

Column G: The answer in Column F measures the weight of packaging material per 100 gallons of juice in ounces. To find out how many pounds of packaging material this is equivalent to, divide the answer in Column F by 16(1 lb. = 16 oz.).

4. In the last column, you found out how many pounds of packaging material it takes to provide 100 gallons of orange juice. That represents the amount of orange juice a family would drink in a year if it drank about two gallons a week. Now let's see how those packaging figures translate into waste being sent to a waste facility. Not all the packaging ends up in a waste facility because some is recycled. Fill out Data Table 2 to see what amount will probably end up as waste.



The chart at right gives the national average for each type of material that is recycled. Use it in answering Data Table 2.

Recycling (Recovery) Rates for Various Packaging Materials

Steel cans	53%
Aluminum cans	65%
Glass containers	29%
Frozen concentrate can	0%
Paperboard carton	1%
HDPE #2 colorless plastic bottles	26%
HDPE #2 colored plastic	11%
PET #1 plastic bottle *	8%
Aseptic (juice) boxes	1%
Mini-sip pouches	0%

**Does not include PET soft drink bottles, which have a recovery rate of 49%.*
Source: Resource Recycling magazine, July 1995

DATA TABLE 2

Here's a guide to the information needed in each column of Data Table 2:

Column A: Note the type of package.

Column B: Find the recycling rate for the type of packaging material.

Column C: Record the weight of the packaging, in pounds, per 100 gallons of juice. (Data Table 1, Column G).

Column D: Figure how many pounds of this packaging can be expected to be recycled. Multiply Column B by Column C.

Column E: Calculate how many pounds of this packaging can be expected to end up at a waste facility. Subtract Column D from Column C.

Coffee Conundrum

CONTENT AREAS

- **Math**
  calculations, volume
- **Science** resources

OBJECTIVES

Students will…

- calculate the amount of waste generated by steel coffee cans and coffee brick packs that is not recovered by recycling
- calculate the amount of fuel saved in transporting coffee cans versus coffee brick packs
- understand that the reason for reducing, reusing and recycling is to conserve resources
- understand that not all recyclable materials are recycled, and a percentage ends up in a waste facility; and understand recycling is a process that also uses resources
- learn that if you start with less material in the first place, you produce significant environmental benefits throughout the life of a product

MATERIALS

For students working in pairs

- Coffee Conundrum Worksheet
- calculators

For the class

- 4 smashed 13 oz. (or similar size) steel coffee cans (smash cans by removing the bottoms, turning them on their sides and flattening them with your hand or foot).
- 13 oz. steel coffee can that is not smashed
- Four 13 oz. (or similar size) wrappers from a coffee brick

TIME

One period, *45 minutes*

Coffee is one of the most popular drinks in the United States and around the world. All of those steel cans make for a lot of waste. That's because about half of the cans end up in landfills. (About 50 percent of cans are recycled.) Perhaps you have noticed a new type of packaging for coffee – it now comes in vacuum packages called coffee bricks. Cans are made of steel, a resource which can be recycled. The brick pack is made of plastic and aluminum foil laminated together and is not currently recycled.

Students investigate two types of coffee packaging. Although one is recyclable, students see that recyclability may not always be the choice that saves the most resources. By investigating steel cans and vacuum brick packs, students will determine which package uses the fewest resources and generates the least waste. Students then decide which is the better choice environmentally. A strong case will be made for source reduction.

PROCEDURE

1. Ask students to answer this question in writing or discussion: "Which is better–recycling or reducing waste?" Ask students to explain their views. It is important that you monitor and clarify but not judge any of their answers.

2. Set out a coffee can and a brick pack. Ask students to spend a couple minutes thinking and/or writing about the advantages and disadvantages of each container. List students' ideas on the board or overhead.

3. Ask students to explain the sequence of events that takes coffee from producer to consumer. Do this as a brainstorming session, listing each step on the board or overhead, starting with "beans are picked." This sequence would be approximately: beans picked (where?), taken to packer, shipped to roaster in the U.S., shipped to market for grinding and packaging, shipped to warehouses or stores for distribution or sale.

4. Have students select a partner or divide the class into pairs. Give each pair a student worksheet and read the introduction. Explain that they will be using a calculator to complete the worksheet.

5. As students proceed through the worksheet, monitor and help students who need assistance. As students complete each part of the worksheet, stop and discuss their answers. Before students complete Part 3 of the student worksheet, stack the three crushed steel coffee cans and stack the 3 brick packs where all students can see them.

QUESTIONS

When students have completed the worksheet, discuss the following:

a. Which is better–recycling or reduction? Why? (Reduction is a better option because recyclable materials are not all recycled and recycling also uses resources.)

b. What should be the goals when dealing with the solid waste problem? (The primary goal is to use fewer resources to reduce the waste that goes to waste facilities.)

c. Which do you think would be a good choice environmentally–coffee in cans or brick packs? Give as many reasons as you can for your answer. (Students should respond using information they calculated showing that less waste and energy savings can be realized with brick packs. You may want to point out this fact: if all steel coffee cans were converted to brick packs, the savings in energy would be the equivalent of 17,200,000 gallons of gasoline.)

d. If coffee bricks use less energy and produce less solid waste, why isn't all coffee packed in bricks packs?(Students will respond with various answers. The discussion should lead students to the idea that companies produce what consumers will buy. If consumers continue to buy coffee packed in cans instead of coffee packed in brick packs, the coffee companies will continue to package coffee in cans.)

e. In this activity, what were you most surprised about? Accept any reasonable answers.

EXTENSIONS

1. Draw a poster illustrating what happens to coffee cans and brick packs from manufacture to solid waste. Show how energy and resources are used in each step.

2. Look at the supermarket for other products that are packaged in plastic/aluminum vacuum packs. Make a list of other products that probably could be packaged this way to save energy and/or reduce waste. Why can some products, such as macaroni and rice, be packaged in plastic bags, while others must be packaged in steel cans or plastic/aluminum vacuum packs.

Teacher Notes

Answers to student worksheet

NOTE: All figures are based on U.S. production. Recycling numbers are the most recent available from Porter and Associates.

PART A

1. (a) 9.6 lbs. (b) 10.4 lbs. (c) 3 lbs.

2. (a) 150,000,000 lbs. (b) 78,000,000 lbs.

3. 25,425, 000 lbs.

4. The brick pack reduces solid waste the most.

5. The waste would be increased by the additional weight and volume of the lid. The recycling rate for these is very low.

6. It may be inconvenient to recycle, or there may be no local recycling program.

7. Although less material is landfilled, our goal is to conserve resources, so the answer is “No.” If 100 percent were recycled, the recycling process for steel and forming a new product uses more energy than making a new coffee brick container.

PART B

1. 5,682 trucks

2. 16,243 trucks

3. 21,925 trucks

4. 15,347,500 miles

5. 2,557,917 gallons

6. Accept any reasonable answer about the benefits of saving fuel.

PART C

1. 2.2 ounces

2. 5,156,250 pounds (Don’t forget that there are 24 cans per case!)

3. a) The brick packs have the least volume.

b) Brick packs are still less, but the cans have obviously reduced their volume significantly.

c) Cans take up more landfill space, by volume, than brick packs. Compacting makes a big difference when it comes to maximizing the use of landfill space.

Coffee Conundrum Worksheet

Names ____

____

One of the most popular drinks in the United States is coffee. With millions of people drinking it, you can imagine that coffee packaging can add up to a lot of solid waste. Most coffee is packed in steel cans, which can be recycled.

Perhaps you have noticed a new type of packaging called coffee bricks. The brick wrap is made of plastic and aluminum laminated together and is not currently widely recycled.

In the following activity we will examine how coffee packaging can have some surprising results when thinking about solid waste. So get your calculator and sharpen up your math skills as we analyze recyclable steel coffee cans and nonrecyclable coffee bricks.

PART A

How much waste reduction can be gained through packaging?

1. Let's figure out how much waste each package produces. A heavy coffee drinker consumes about 65 pounds of coffee each year. If two 65 pound batches of coffee were packaged, one batch in 13 ounce cans and the other in 13 ounce bricks, the steel in the cans would weigh 20 pounds; the brick pack wrappers would weigh 3 pounds.

It appears that the metal coffee cans produce more waste. But what about recycling? The brick pack isn't widely recycled and the steel is. The current national recycling rate for steel cans is about 48 percent according to the Steel Recycling Institute. So, for our 65 pound batch of coffee,

a. How many pounds of steel would probably be recycled? ________________ pounds of steel recycled

b. How many pounds would end up as waste? ________________ pounds of steel waste

c. How does this compare with waste from an equivalent amount of coffee packaged in brick packs? (Because recycling rates are not available for brick packs, assume that none are recycled for this activity.) ________________ pounds of brick pack waste

2. Currently, the coffee industry uses about 900 million packages per year–600 million cans and 300 million brick packs. A 13 oz. coffee can weighs about 4 oz., while a brick pack that can hold the same amount of coffee weighs 0.452 oz.

a. How many pounds of cans are used each year? ________________ pounds of steel used

b. At the current recycling rate, how many pounds of cans would end up in a landfill or waste facility? ______________________ pounds of steel waste

3. If all 900 million packages of coffee were packaged in brick packs, how many pounds would go to a waste facility?
__________________ pounds of brick packs

4. Based on these figures, which type of packaging most reduces solid waste?

____

____

____

____

5. The steel can has a plastic lid. How would this affect the total waste of canned coffee?

____

____

____

____

6. Why aren't all steel cans recycled?

____

____

____

____

7. If 100 percent of steel cans were recycled, would that make steel a better choice? What energy considerations are there?

____

____

____

____

PART B

What other energy is involved with packaging?

1. All of the packaged coffee must be transported. For the packager to deliver 900 million packages of coffee per year, 28,409 trucks would be needed for cans and 22,727 trucks for brick packs (brick packs take up less space). How many fewer trucks would be needed for brick packs each year?
__________________ fewer trucks for brick packs

2. Containers (empty steel cans or brick packs) also have to be delivered to the packager before they can be filled. If all the coffee were packaged in cans, 17,140 trucks. If all the coffee were packaged in brick packs, 897 trucks would be needed. How many fewer trucks would be needed if all the coffee were packaged in brick packs?
__________________ fewer trucks for brick packs

3. How many fewer trucks would be needed each year to transport both coffee and containers if all 900 million packages of coffee were brick packs?
__________________ total fewer trucks each year

4. Each truck averages 700 miles in delivery distance per year. How many miles of travel have been eliminated assuming #3?
__________________ fewer miles of travel each year

5. Each truck averages 6 miles per gallon. How many gallons of fuel would be saved each year by packaging coffee in brick packs?
__________________ gallons of fuel saved each year

6. Why it is good to use less fuel? List all the reasons you can think of.

PART C

What other environmental savings are related to using brick packs?

1. In addition to the container that holds the coffee (cans or packs), called the primary container, there is another container that holds all the cans or packs during shipping. This container is called the *secondary container.* For coffee cans, it is a cardboard box. Twenty four (13 oz.) cans of coffee are held in a cardboard box that weighs 16.3 ounces.

The secondary container for brick packs is cardboard trays: one on the top and one on the bottom of 24 brick packs. Then they are shrink wrapped with plastic to hold them together. This packaging weighs 14.1 ounces. How many ounces of packaging material are saved by using brick packs?
________________ ounces saved for each 24 bricks

2. There are approximately 900 million 13 oz. packages of coffee sold each year. What would be the savings in pounds of solid waste from secondary packaging by using brick packs instead of cans?
________________ pounds of waste saved

3. In this activity, we've been talking about the weight of packaging. In a landfill, the volume or amount of room something takes up is important. Look at the stack of three coffee cans and three brick packs.

a. Which takes up less space?

Now, consider the fact that items are compacted prior to landfilling. Stand on the cans and wrappers and crush them. (You can also try putting them between two books and crushing them.)

b. How much of a difference did this make?

c. How would that be important to waste disposal in landfills?

What's Hazardous About Household Products?

CONTENT AREAS

- **Science**
  classification, chemical safety codes
- **Home Economics**
  safe, alternative products

OBJECTIVES

Students will…

- learn the characteristics of hazardous materials and use them to classify some common household substances
- become aware of the safe use and disposal of hazardous household materials

MATERIALS

For each student

- sealed samples of common household products
- Classifying Household Waste data sheet
- safety glasses

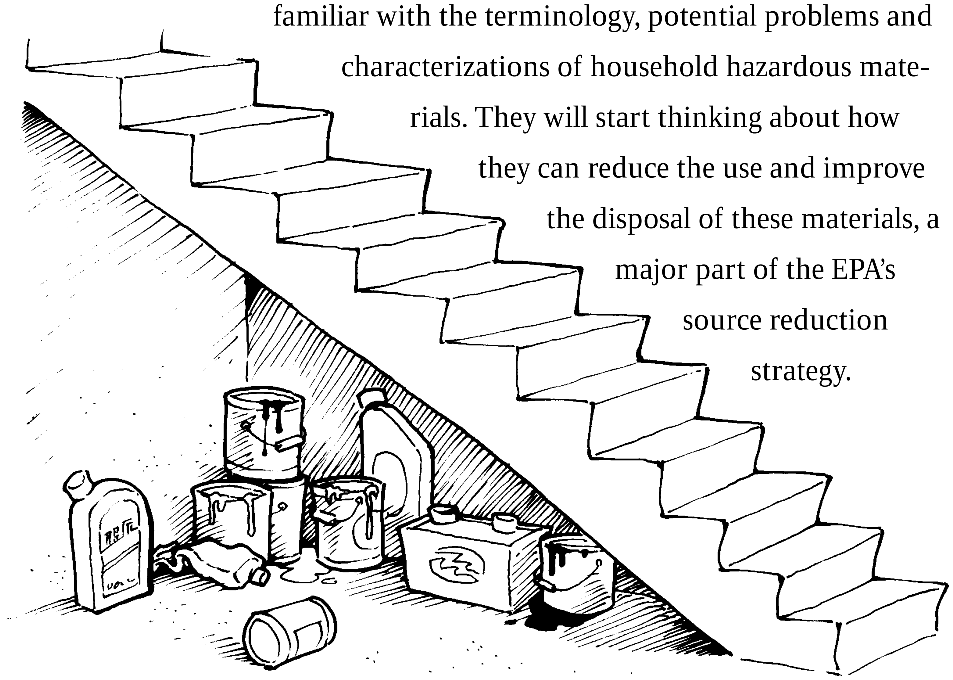
TIME

Two periods
45 minutes each

EPA (Environmental Protection Agency) officials have stated that the biggest problem with landfills isn't that they are filling up, but that they contain hazardous and toxic wastes. Over time, these wastes can leach into soil and groundwater, creating all sorts of health and environmental problems. Many of these wastes come from homes, not just from factories. It has been estimated that many American homes contain three or more gallons of hazardous waste.

We use hazardous products every day in the kitchen, bathroom, basement, workshop, garden, yard and garage. Many are safe if used, handled, and disposed of according to directions. However, if proper procedures are not followed, these substances can cause a variety of environmental, health and safety problems.

In this activity, students classify hazardous waste and become familiar with the terminology, potential problems and characterizations of household hazardous materials. They will start thinking about how they can reduce the use and improve the disposal of these materials, a major part of the EPA's source reduction strategy.



PREPARATION

1. Collect a variety of common household products. Try to include at least one product from each of the four categories used by the EPA to classify hazardous waste: ignitable, corrosive, reactive and toxic. Include safe cleaning alternatives such as vinegar, baking soda, salt and lemon juice. Select materials that have enough information on the label to allow the students to make a decision as to the product's safety without relying too much on prior information or guessing. (For assistance in selecting products, refer to the lists in Teacher Notes.)
2. Seal all of the products, whether the container is full or empty, in clear plastic bags.
3. Set up stations around the classroom. Place one product at each station.

PROCEDURE

1. Show students two or three common household hazardous products. Ask students to identify what is hazardous about each. Accept reasonable answers. Inform students they will be doing an in-depth analysis of several products.
2. Instruct students to wear safety glasses during the activity and NOT to open any of the bags unless bottles are completely empty.
3. Give each student a data recording sheet. It includes definitions of the four main categories used by the EPA to characterize hazardous materials. If necessary, instruct students on how to read a label.
4. Instruct students to rotate from station to station, examining and classifying each product according to the EPA criteria. (Some products may fit into more than one category.) As a speedier alternative, make sure that products from all four classifications are at each station, divide the class into four groups, and have each visit one of the stations.

   In completing their data recording sheets, students should support their classification of each product with some concrete evidence from their observation. Suggest safe methods of handling and disposing of each of the products. Also suggest any safe, nonhazardous alternatives to the product. (See Teacher Notes for alternatives list.)

QUESTIONS

When all students have examined all the products, compare, discuss and debate their findings. When discussing management methods for hazardous waste, point out how source reduction is the best option because it does not use or produce any hazardous materials.

a. Which products have more than one classification?

b. Which product has the most codes?

c. Which products do you have at home?

d. Should there be a warning on any of these products?

e. How might warnings affect consumer purchases?

f. Do some products already have warnings? Are the warnings obvious and detailed enough?

EXTENSIONS

1. Ask students to inventory common products at home and use the same criteria to determine the characteristics of each. Where is it stored? How old is it? How much is left? How should it be handled or disposed of? Share and analyze the results. Are some materials common to many lists? What are they? Compute a tally of the five most common hazardous products. Post the inventory sheets and the tallies.

2. Ask students to find and scientifically test a safer alternative for at least one of the most common hazardous products. How/why does it work? Is it effective?

3. Have students develop a marketing campaign for the safer alternative. They should develop new labels and advertising (print, radio, TV) as part of the campaign.

The Dose Makes the Poison

When it comes to hazards or toxicity, sometimes we have to go beyond the quality of a particular material or chemical to consider the quantity as well. Pool chemicals are a good example. In concentrated forms, these chemicals can be extremely dangerous to people, animals and plants. However, in miniscule amounts, the same chemicals actually reduce the risk of certain health hazards by controlling the level of organisms that can cause health problems in humans.

Here's an interesting way to explain this concept to the class:

There's a widely used chemical called dihydrogen monoxide, or hydroxyl acid. In large doses, this compound can kill. The same is true if only taken in miniscule amounts and restricted to a few drops a week. Further, this chemical causes metals to corrode, is a major cause of flooding and environmental devastation and is the principal ingredient in acid rain. By now, you've certainly laughed at what this chemical compound is–water!

Classifying Hazardous Household Waste Data Record

Name(s) ______________________________

EPA Classification Codes of Hazardous Materials

Category	Potential hazard
Ignitable/flammable	Easily catches on fire
Corrosive	Causes deterioration, etching, or eating away of body tissue and other surfaces that it touches. Strong acids and bases fit into this category
Reactive	Dangerous, unwanted reactions, explosions or detonations can occur from unstable ingredients or when the material is mixed with or exposed to other substances
Toxic	Poisonous; may cause injury or death if swallowed, inhaled, or absorbed through the skin. Most household chemicals are toxic and even fatal if ingested in large enough quantities
Irritant*	Causes redness, inflammation, or soreness to skin, eyes, mucous membranes or the respiratory system
Carcinogenic*	Known to cause cancer

**Irritant and Carcinogenic are codes used in some classification systems*

Data Recording Table

Material (name)	Classification code(s)	Reasons for assigning code	Disposal method	Safe alternative

Teacher Notes

Classification of Some Household Hazardous Products

Note: These are based on generalizations for a given product. However, there are many manufacturers that use various ingredients for the same product. Labels should always be checked to determine a given product's status or code.

Product Classification	Hazard Code
hair spray/hair dyes	toxic, flammable
nail polish remover	flammable, toxic
medicines	toxic
all-purpose cleaners	toxic, flammable, corrosive
ammonia	toxic, reactive
chlorine bleach	toxic, corrosive, reactive
brass/silver polish	toxic, flammable, corrosive
disinfectants	toxic, flammable, corrosive
drain openers/cleaners	corrosive, reactive, toxic
furniture polish/waxes	flammable, toxic
oven cleaners	corrosive, toxic
rug/upholstery cleaners	toxic, flammable, corrosive
spot cleaners/removers	toxic, flammable
toilet bowl cleaners	toxic, corrosive
window cleaners	toxic
antifreeze	toxic
brake fluid	flammable, toxic
car batteries	corrosive, reactive
motor oil	flammable, toxic
paints	flammable, toxic
preservative (wood)	toxic, flammable
solvents/thinners	toxic, flammable
stains/sealants/varnishes	flammable, toxic
strippers/removers	toxic, flammable
mothballs	toxic
rodent poisons	toxic
insecticides	toxic
herbicides/fungicides	toxic
ant/wasp/roach sprays	toxic
flea powders/sprays	toxic
swimming pool chemicals	toxic, corrosive, reactive
charcoal lighter fluid	flammable
photo-developing chemicals	toxic, flammable, corrosive

Disposal of Hazardous Household Products

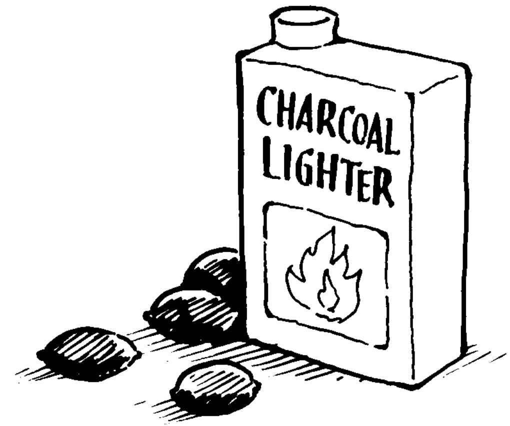
The disposal method of choice for most hazardous products is to fully use the product as quickly as possible or to give the remainder in the original container to someone who will use it. In most cases, the empty container can then be disposed of in the local landfill. If the product cannot be totally used up, the unused portion should be tightly sealed and stored in a labeled container until it can be disposed of when household hazardous waste is collected in your community.

A few products can be discharged into the sewer system, provided they are disposed in small quantities, one chemical at a time, and flushed with a large quantity of water. These include ammonia, bleach and disinfectants.

A few products can be recycled by taking them to a special recycling center. These include motor oil, antifreeze and in some locations, batteries.

Teacher Notes

SAFE ALTERNATIVES
to Hazardous Household Products



Drain cleaner
Use a plunger or plumber's snake.

Oven cleaner
Clean spills as soon as the oven cools using steel wool and baking soda. For tough stains, add salt. (Not for self-cleaning ovens.)

Glass cleaner
Mix 1 teaspoon of vinegar or lemon juice in 1 quart of water. Spray on and use newspaper or cloth to wipe and dry.

Toilet bowl cleaner
Use a toilet brush and baking soda or vinegar.

Furniture polish
Mix 1 teaspoon of lemon juice in 1 pint of mineral or vegetable oil and wipe furniture.

Rug deodorizer
Sprinkle liberal amounts of baking soda on the rug. Wait 15 minutes and vacuum.

Metal polish
Use natural acids such as lemon juice, sour milk, ketchup, etc. and give them plenty of time to work.

Plant sprays
Wipe leaves with mild soap and water; rinse.

Mothballs
Use cedar chips, lavender flowers, rosemary, mint or white peppercorns.

Flea and tick products
Put brewer's yeast or garlic in your pet's food; sprinkle fennel, rue, rosemary or eucalyptus seeds or leaves around animal bedding. Or use a flea comb.

Rats, mice, rodents
Get a cat or use a trap.

Insect garden pests
Use boric acid. Introduce predators such as ladybugs, ground beetles or praying mantis. Plant marigolds.

Roach and ant killers
Place boric acid in and along cracks.

Fertilizers
Use manure or home-composted products.

Stain remover
White chalk as a substitute for spot cleaners that remove oil stains

Air freshener
Cinnamon and cloves or potpourri

Rug cleaner
Club soda

Paint and grease cleaner
Baby oil

General cleaning
(bathroom and kitchen)
Baking soda

Finding Safer Substitutes

CONTENT AREAS

- **Science**
  acids/bases, scientific method

OBJECTIVES

Students will…

- recognize that many hazardous household chemicals are not necessary
- prepare, test and evaluate the effectiveness of alternative silver metal cleaners

MATERIALS

For each group of two or three students

- Safer Substitutes Worksheet
- commercial silver polish
- 2 tarnished silver items (dimes will work; don't use valuables or antiques)
- dab of white toothpaste
- drop of olive oil
- soft, nonabrasive cloths
- large beakers or glass or plastic bowls large enough to hold the silver items
- piece of aluminum foil sized to fit container bottom
- 1 tablespoon salt
- 1 tablespoon baking soda
- water
- kitchen measuring spoons
- safety glasses

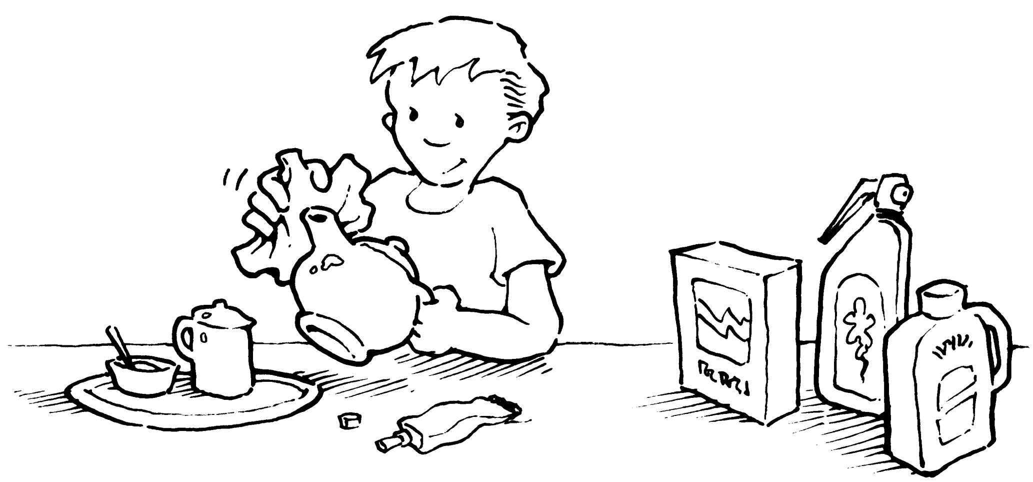
TIME

Two periods, *45 minutes each*

Many common household products are not only hazardous, but they are also often expensive and unnecessary. Commercial silver cleaners and polishes remove and prevent tarnish. They usually contain acids, ammonia derivatives, surfactants, mild abrasives and anti-tarnish ingredients, such as wax or polyethylene glycol. All of these chemicals are classified as irritants. Acid fumes cause headaches and some are flammable. All are corrosive and toxic.

Simple washing and wiping with soap and water will not remove the tarnish. Scouring with harsh abrasives or steel wool pads will permanently scratch and scar the soft metal. However, safe, effective and less expensive alternatives can often be found in most grocery stores. Most rely on the action of natural acids such as citric acid from lemons, or lactic acid from sour milk.

In this activity, students test two, safe alternatives for cleaning silver. One uses toothpaste and the other uses baking soda, salt, and aluminum foil.



PROCEDURE

1. Show students a tarnished silver item that, when viewed from a distance, is difficult to distinguish as silver. Ask students to tell you what it is made of. Discuss why they may have had trouble telling it was silver.

2. Ask students how they could get it clean. Would ordinary methods, such as wiping with soap and water or using an abrasive scouring pad, work? Why or why not? Invite a student to try one of these methods. Discuss why this method did not work. (See Teacher Notes for answers.)

3. Display a sample of silver polish and reveal its ingredients and possible health affects. Ask the class to assign it a hazardous materials classification code (see Teacher Notes).

4. Discuss any alternatives to the harsh chemicals that students suggest. Students may not have any alternatives, but if there are suggestions, discuss how you could test each.

5. Inform students they will test and evaluate two alternatives in class. Divide the class into groups of two or three students. Give each group two tarnished silver items and a copy of the Safer Substitutes Worksheet.

6. Have students clean one object with Alternative Method A:

a. Place a small amount of white toothpaste directly on the object.

b. With a soft cloth or rag, work the paste onto the surface of the object, concentrating on the heavily tarnished areas. Using a drop of olive oil will make the toothpaste spread more easily. As the tarnish begins to disappear, the toothpaste will turn grey and you may detect a slight smell of sulfur. Can you explain the smell? (See Teacher Notes.)

c. Allow the paste to dry. Rinse it off with hot water. Buff the object dry with a clean, soft cloth. (See Extension #6 for help in tarnishing a silver item.

7. Have students clean the other object with Alternative Method B:

a. Fill the glass or plastic container with enough water to completely cover the silver item, but do not put the item in the water.

b. Mix 1 tablespoon of salt and 1 tablespoon of baking soda into the water. Observe and note the properties of the solution.

c. Cut a sheet of foil to fit into the bottom of the container. Carefully observe the foil before adding it to the container. Sink it to the bottom.

d. Add the silver item and let it stand several hours or overnight.

e. Remove the object, rinse, dry and observe.

f. Observe the aluminum foil. How has it changed? Can you explain this? Observe the solution. Has it changed? (See Teacher Notes.)

g. Recycle the aluminum foil and pour the solution down the drain.

8. As a teacher demonstration, clean a silver object with the commercial silver polish. Have the students observe it and make comparisons.

Alternatively, if there are enough gloves and polish, have the students clean a third item.

QUESTIONS

When the activity and worksheets are complete, discuss students' answers to the worksheet questions. Also discuss how/why each method works.

a. Why are alternative methods preferable to commercial products?

b. Were the alternative methods as effective as the commercial products?

c. Which method was the most expensive? Which was the cheapest?

d. Which method took the most time?

e. Which method was the messiest?

f. Which method is the best in terms of source reduction?

EXTENSIONS

1. Calculate the cost of commercial silver polish versus alternatives A and B.

2. Find alternatives to other polishes. Test them. How effective are they? Why do they work? Test each alternative to see if it is an acid or a base. Which work best? (See Teacher Notes.)

3. Test the alternatives listed in Activity 9 against their commercial counterparts.

4. Silver should be stored in a tightly wrapped, soft cloth. Why does this help prevent tarnish? Research why silver tarnishes and exactly what tarnish is.

5. As a class demonstration or at-home lab, test this old-fashioned cleaning method. Put the tarnished silver in a plastic or glass bowl or dish. Add enough sour milk or buttermilk to cover it. Let it soak overnight. Rinse, buff and dry the silver. If no sour milk or buttermilk is available, add either cream of tartar, vinegar or lemon juice to whole milk. Why do these methods work? (All of the mixtures contain natural acids.)

6. As a reverse, take a clean silver item and expose it to raw egg yolk or mustard. Allow the yolk to dry and then clean it off. The silver item turns black. Why? (Eggs and mustard contain sulfur. Silver reacts with hydrogen sulfide.)

7. Give extra credit to students who research why silver tarnishes and write out the chemical equation for the reaction.

Teacher Notes

Metals tarnish or discolor when they are exposed to moisture and the atmosphere. Silver, for example, reacts to airborne traces of hydrogen sulfide. The hydrogen sulfide combines with the silver to form a brownish black coating of silver sulfide. (That's why cooking and eating utensils tarnish if they are brought in contact with foods that contain sulfur, such as eggs or mustard.)

Commercial silver cleaners and polishes remove and prevent tarnish. They usually contain acids, ammonia derivatives, surfactants, mild abrasives and anti-tarnish ingredients, such as wax or polyethylene glycol. All of these chemicals are classified as irritants. Acid fumes may cause headaches and some are flammable. All are corrosive and toxic.

Multi-purpose metal cleaners usually contain abrasives, harsh acids, ammonia, alcohol and water. Ammonia vapors are potentially harmful, and all of these chemicals are both toxic and irritating to the skin and eyes.

Acid is an important ingredient because many metals react with acids, releasing hydrogen gas when it is applied. The metals replace the hydrogen in the acid, and the reaction can often be seen as tiny bubbles or fizzing. Safe, natural acids from lemons, sour milk, yogurt, ketchup or white vinegar all make fine substitutes if given ample time to work.

Simple washing and wiping with soap and water will not remove the tarnish. Scouring with harsh abrasives or steel wool pads will permanently scratch and scar the soft metal. However, safe substitutes can be found that work very well. Most rely on the action of natural acids, such as citric acid from lemons or lactic acid from sour milk. Toothpaste is mildly abrasive.

In using baking soda, salt, and aluminum foil, a replacement chemical reaction results. Because aluminum is more reactive than silver, the sulfide is loosened from the silver and combines with the more reactive aluminum, turning the foil blackish brown and cleaning the silver.

The baking soda prevents the formation of a protective oxide coating on the aluminum. The process is more rapid with the presence of salts because they make the water more conductive.

Safer Substitutes Worksheet

1. Write a detailed observation of each object, noting where the tarnish is heaviest before beginning to clean.

Object 1 ____________________

____

____

____

Object 2 ____________________

____

____

____

2. Clean one object with Alternative Method A.

a. Place a small amount of white toothpaste directly on the object.

b. With a soft cloth or rag, work the paste onto the surface of the object, concentrating on the heavily tarnished areas. Using a drop of olive oil will make the toothpaste spread more easily. As the tarnish begins to disappear, the toothpaste will turn grey and you may detect a slight smell of sulfur. Can you explain the smell?

____

____

____

____

____

____

c. Allow the paste to dry. Rinse it off with hot water. Buff the object dry with a clean, soft cloth.

3. Clean the other object with Alternative Method B:

a. Fill the glass or plastic container with enough water to completely cover the silver item, but do not put the item in the water.

b. To each 240 ml of water, mix in 1 tablespoon of salt and 1 tablespoon of baking soda. Observe and note the properties of the solution.

c. Cut a sheet of foil to fit the bottom of the container. Carefully observe the foil before adding it to the container. Sink it to the bottom.

d. Add the silver item and let it stand overnight.

e. The next day, remove the object, rinse, dry and observe.

f. Observe the aluminum foil. How has it changed? Can you explain this? Observe the solution. Has it changed?

____

____

____

____

____

____

____

____

____

g. Recycle the aluminum foil and pour the solution down the drain.

QUESTIONS

After completing the procedure for each method, examine the objects and answer these questions:

a. How do the objects compare with their original descriptions?

b. Is each method effective as a substitute? Explain.

c. Does either method involve hazardous properties? If so, which ones?

d. How do the ingredients of the alternative methods compare with the ingredients of the commercial silver polish?

Retrace Your Waste: Life Cycle Analysis

CONTENT AREAS
- **Science** natural resources, energy use, air quality, water quality, solid waste, recycling
- **Geography** natural resources

OBJECTIVES
Students will…
- learn to use life cycle analysis to identify consumption of energy and materials and waste production in the life of a product as it moves through several stages from "cradle to grave"

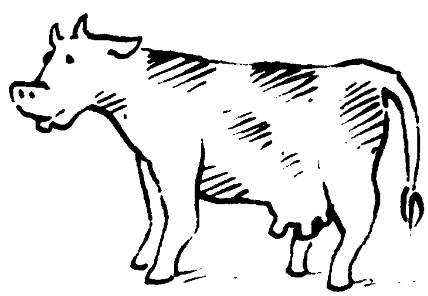
MATERIALS
For the class
- Life Cycle Inventory
- Life of a Hamburger poster
- index cards
- varied assortment of consumer products and/or containers manufactured from a wide range of raw materials. Include items with which students are familiar.
- aluminum soda can
- newspaper or magazine
- clothing made from natural material
- small electronic device
- clothing made from synthetic material
- pencil or pen
- plastic or glass soda bottle
- school computer
- variety of food products with packaging
- handbag or backpack
- disposable diaper

TIME
Two periods,
45 minutes each

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

Although evaluating products over their entire life cycle can give a more complete picture, the process can be extremely complex. That's because products are evaluated through each of the six stages of the life cycle:

1. Acquisition of raw materials
2. Manufacturing and processing
3. Distribution and transportation
4. Use/reuse
5. Recycling
6. Disposal



Along the way, each stage receives inputs of materials and energy and creates outputs of waste emissions. Overall, these stages may have a significant environmental impact. This activity uses a game to introduce students to life cycle analysis. In the game, students use logical and critical thinking skills to trace a product through its life cycle in reverse order.

PROCEDURE

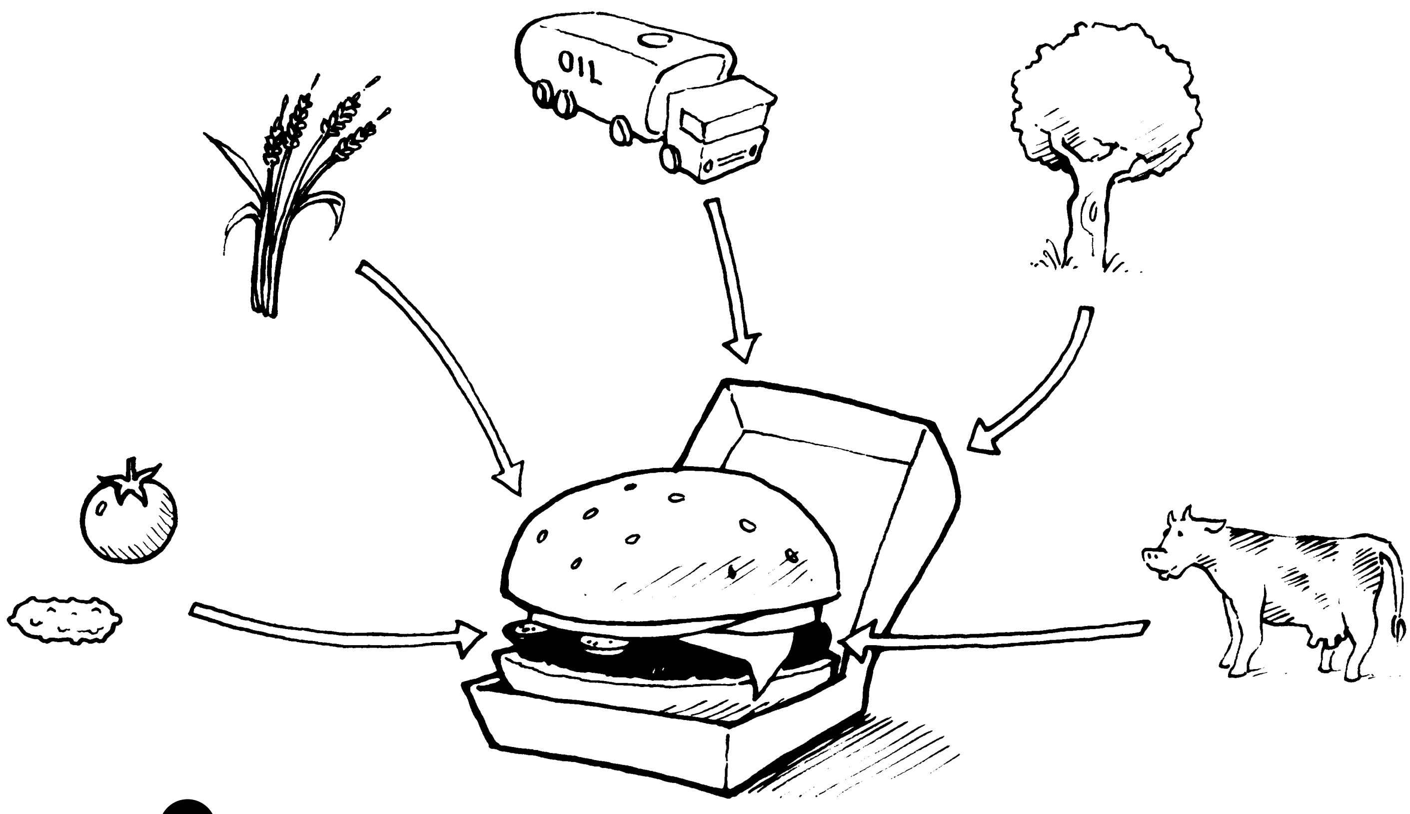
1. Introduce the concept of life cycle analysis. Use the chart as a handout or overhead. Lead students through the stages of the life cycle of a product, beginning with obtaining raw material and ending with disposing of the product. Along the way, give various examples of how energy is consumed and how waste products from air emissions, water effluents and solid waste are produced.

2. Inform students they will be retracing the life cycle of a product from its disposal to its raw materials source. Explain that life cycle analysis is actually very complicated, with several divergences along the path. It's all right if students do not see all the connections, but major ones should be grasped.

3. Instruct students to sit in a circle. Place the objects you have brought to class in the center, designated as the "waste stream," where the product is finally disposed of.

4. Explain the activity. One student will select an object from the waste stream. Beginning with the student who selected the object and moving clockwise around the circle, have students tell a life cycle story about the product, each student building on the previous student's statement. The first student starts with raw materials. The rest work through transportation, manufacturing and processing, packaging consumer purchase, use and disposal. (It may be helpful to write the steps on the chalkboard.)

5. As a warm up, the teacher should put up the poster and use a fast-food hamburger as an example. Hand students numbered index cards, which they can read from to trace the steps. For example, the teacher will start by saying "Let's take a look at all of the preparation that goes into serving a hamburger."



1. Grain is grown, using a variety of fertilizers, herbicides, pesticides and significant amounts of water. Threshers, combines and tractors are used to sow, grow and reap the grain. All of this equipment burns fuel and emits pollutants and greenhouse gases.

2. The grain is shipped to cattle ranches or feedlots, where it is fed to cattle, along with water. Waste products include manure and methane.

3. Cattle are shipped by truck or train to market, where they are fed and sold. They are shipped again to processors.

4. At processing plants, the cattle are slaughtered and cut into large sections called primal cuts. These must be quickly refrigerated and aged. Waste products include unusable animal parts, waste water and manure.

5. The beef is shipped in refrigerated trucks and rail cars to food service warehouses, where it is ground, formed into patties and boxed and wrapped for use. It is stored and frozen until needed.

6. Beef patties are shipped via freezer trucks to stores and restaurants. They are kept in cold storage until needed, then cooked on a broiler or fryer. They are then put on a bun, topped with condiments, wrapped and put under hot lights until served.

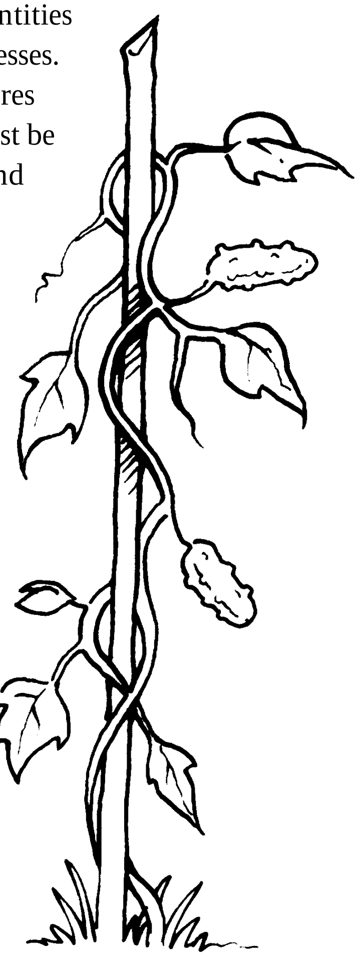
7. Uneaten portions are thrown away.

Bun and condiments

8. Grain is grown for use in baking. Tomatoes, onions, pickles and lettuce are grown, using fertilizer, pesticides and herbicides, plus large quantities of water. Farm machinery is required. The machinery uses fuel, and some of the chemicals run off into water reserves.

9. Grain is shipped to mills, where mechanical equipment converts it into flour. The flour is packaged in bulk bags. Wastes include excess or unusable portions of the grain and excess packaging material. Vegetables are shipped to refrigerated warehouses, and held in storage until needed. Then, they are sent by refrigerated truck to stores and restaurants, where they are cut up, cooked and served.

10. Some tomatoes, cucumbers and onions are shipped to processing companies. Using mechanical equipment, tomatoes are processed into ketchup, cucumbers are pickled, and onions and pickles are used to make relish. Significant quantities of water are used in these processes. Ketchup production also requires high heat cooking. All food must be vacuum packed for freshness and sanitation.



11. The flour is shipped by truck or rail to bakeries, where it is mixed with water and other ingredients. The dough is then baked in ovens, which require significant heat energy in the form of gas, oil, electricity or wood. Once cooled, the buns are packaged and warehoused. Condiments also are packaged and shipped to warehouses. Then they are shipped to local stores. Waste includes leftovers, which are thrown away.

12. The buns are trucked to local stores, where they are used to make hamburgers. Waste includes leftover bread, which is thrown away.

Packaging

13. Trees are cut and oil or gas is drilled. The lumber and petroleum are shipped or piped to mills and refineries, respectively. Sand, soda and potash are mined and shipped to glass plants.

14. At the mill, lumber is pulped, using very large quantities of water and corrosive chemicals, including chlorine. Large machines then turn the pulp into paper, which is wound on rolls and stored.

At the refinery, petrochemicals are converted into ethylene, which is then polymerized to become polyethylene. Polyethylene is formed into pellets, packaged in bags and boxes and stored. Significant energy is required during these processes.

At the glass plant, the ingredients are mixed into the proper proportion and heated to very high temperatures, at which they melt to form glass. The molten glass is poured into molds and cooled to make bottles.

15. The paper and plastic are shipped via truck or rail to manufacturing plants, which make a variety of products: poly-coated paper for use in wraps and boxes (“clam shells”), paper for use in bags, plastic wrap for use in bread, meat and vegetable packaging and cardboard for use in pallets and boxes.

Glass bottles are shipped to the ketchup and relish plants, which use them for packing.

16. Finished packaging is shipped to points where it is needed. Wastes include most, if not all of the used packaging, including the clam shell and/or wrap used to provide you with a fresh-cooked, sanitary hamburger.

QUESTIONS

Have students discuss and summarize the life cycle analysis. Questions might include:

a. What inputs and outputs resulted from manufacturing this product?

b. Are all the outputs equal in terms of environmental effects?

c. What were the environmental effects, and could any be minimized?

d. What other resources were consumed as a result of this product’s manufacture and distribution?

e. Do you see how using less has a huge impact throughout a product’s life?

At the end, ask students:

a. Will you look at products differently now?

b. What considerations do you now have as consumers that you did not have before?

c. Do you see how using less has a huge impact throughout a product’s life?

d. Where does the real waste occur in the production of hamburgers?

EXTENSIONS

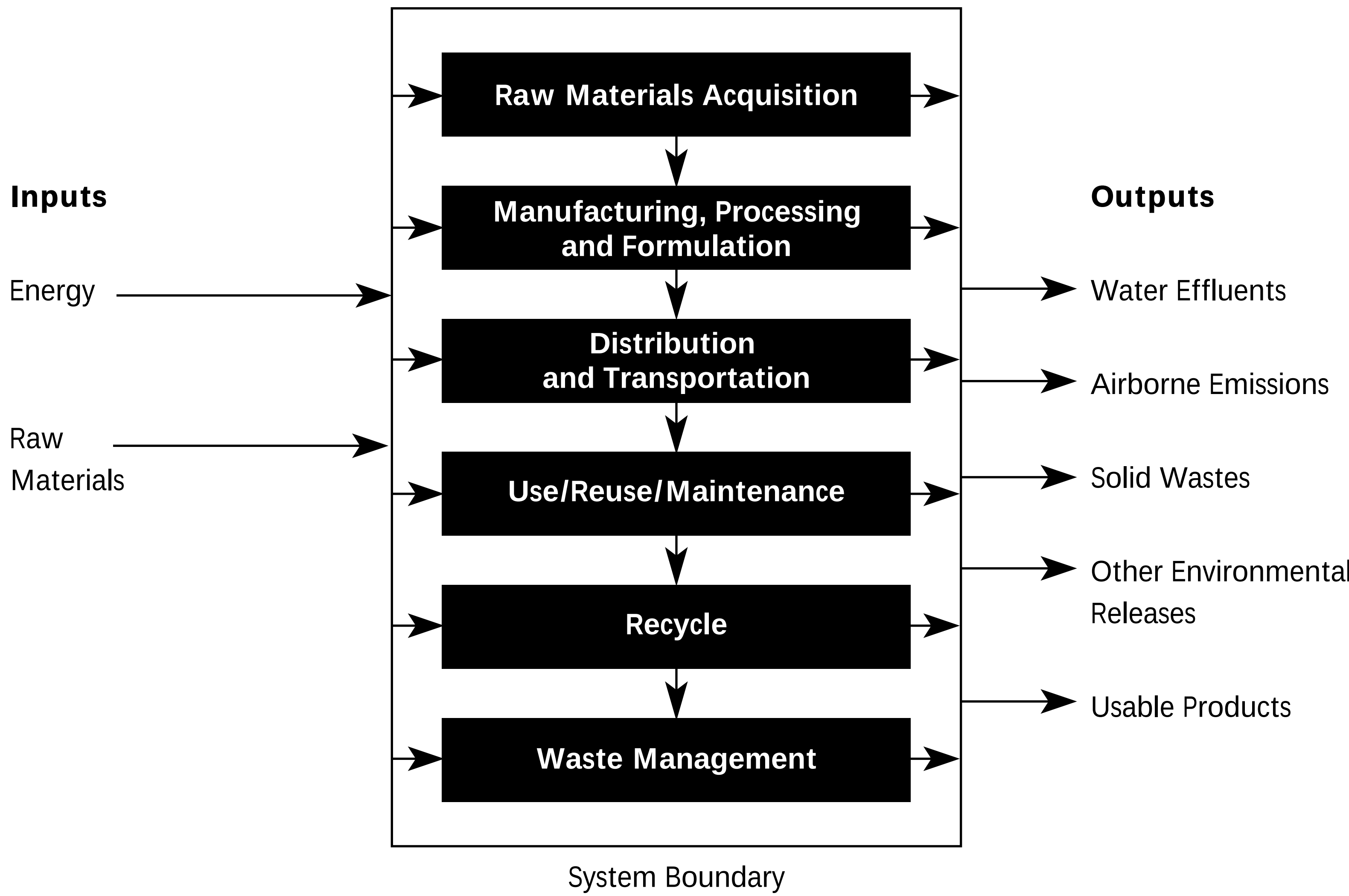
1. Have students work in small groups to research a business to learn its operating philosophy, manufacturing approach, environmental position, research and development activities, and special problems relating to its industry, including waste management.

2. Ask students to select a favorite item and research and then write or illustrate a life cycle analysis about it. If possible, have them contact manufacturers for information.

3. Draw your own life cycle posters.

4. Determine where and what types of waste are generated.

Life Cycle Inventory



Paper or Plastic?

A Life Cycle Analysis Perspective

CONTENT AREAS

- **Science**
  solid waste, energy resources, air quality
- **Math**
  data analysis

OBJECTIVES

Students will…

- use the concept of life cycle analysis to make comparisons between different products that have the same use: paper and plastic bags
- use actual data to compare the relative environmental impacts of the two products

MATERIALS

For each student

- Paper or Plastic? Life Cycle Analysis Worksheet
- paper grocery bag
- plastic grocery bag
- Life Cycle Inventory and Poster from Activity 11

TIME

One period

45 minutes

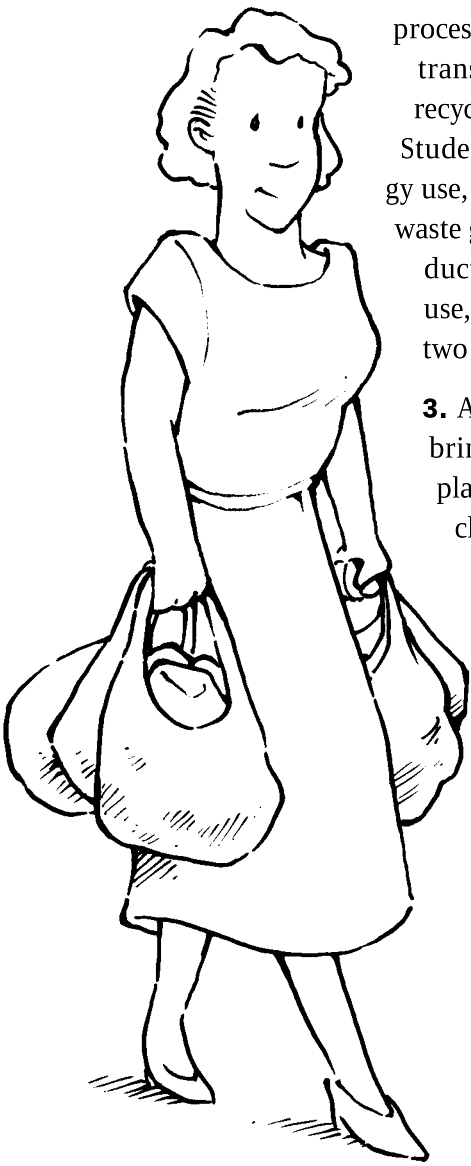
At the supermarket, consumers must decide whether they want their groceries placed in paper bags or plastic bags. Sometimes, consumers bring their own reusable grocery bag. Consumers make choices based on the amount of groceries purchased, convenience, reusability and their perception of the relative environmental impact of these two products.

In this activity, students will analyze the life cycle of each bag to collect data on material composition, energy consumption and waste. For paper bags, the life cycle stages consist of timber harvesting, pulping, paper and bag making, product use and waste disposal. For plastic (polyethylene) bags, the steps involve petroleum or natural gas extraction, ethylene manufacture, ethylene polymerization, bag processing, product use and waste disposal. In all of these steps, energy is required and wastes are generated. When finished, students may have a very different perspective on which product is most efficient, thanks to a variety of source reduction benefits. Only a life cycle analysis can reveal the various factors leading to their decisions.

PROCEDURE

1. Ask students which type of bag they or their families prefer when they go to the supermarket – paper or plastic? Ask them to explain the reasons for their choice.

2. Tell students that they will examine the relative environmental impacts of paper and plastic bags by doing a life cycle analysis. Review the steps a product goes through from "birth to death:" acquisition of raw materials, manufacturing and processing, distribution and transportation, use/reuse, recycling, and disposal. Students will compare energy use, material input, and waste generation in the production, transportation, use, and disposal of these two types of bags.



3. Ask each student to bring one paper and one plastic grocery bag to class. Consider the differences in product use by evaluating paper versus plastic bags according to the following:

- volume
- strength
- rigidity (stiffness)
- ease of packing groceries
- ease of carrying
- weight

Make a chart on the board to record the students' answers or have students create a data table to record their answers.

4. Perform the following demonstration to represent to students the amount of space each type of bag might take up in a landfill:

Stack an equal number of plastic and paper bags and compact them by pressing them down. (*To ensure that the compaction is roughly equivalent, select an equal number of books to set on each stack.)* Measure the height of each stack. Ask students to compare the plastic stack with the paper. Which is higher? How much higher? Tell students that 1,000 paper grocery bags stack up to 46 inches, while 1,000 plastic bags stack up to 3.5 inches. (Using the *length x width x height* equation, students can also determine the differences in volume.)

5. Give students a copy of the *Paper or Plastic? Life Cycle Analysis Worksheet.* Have them answer the questions and do the calculations in groups or individually. You may also want to show them the *Life Cycle Inventory* diagram and the poster from Activity 11.

QUESTIONS

When students have completed their worksheets, discuss their answers. Keeping in mind the comparisons for the various life cycle stages, have students analyze their reasons for choosing paper vs. plastic.

a. Would you make a different choice based on what you now know?

b. Discuss the importance of looking at all the evidence and not basing our decisions on preconceived notions.

c. Do you need a bag for every purchase?

Conclude the discussion by exploring how each type of bag can make a significant contribution to source reduction. Because plastic bags are both strong and lightweight, they can do the same job using less material and taking up less space. In addition, the manufacture, use, and disposal of plastic bags creates less impact on our air, land, and water.

Paper bags may take up more space, but they also hold more groceries. In addition, paper bags are made from a renewable resource. (But don't forget that they consume nonrenewable resources in their production.)

EXTENSIONS

1. Discuss the use of cloth or net grocery bags. When are these bags apt to be used? What significant impact would this have on source reduction? What if you used cloth or reusable bags for all of your purchases? How many bags would you save each week?

2. Create a list of multiple ways to reuse plastic and paper bags.

3. Divide the class into two groups. Have each side prepare a persuasive argument why their bag is the better choice.

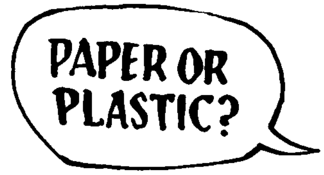
4. Explore the energy output from incinerating plastic vs. paper bags.

REFERENCES

1. *Resources and Environmental Profile Analysis of Polyethylene and Unbleached Paper Grocery Sacks*, Franklin Associates Ltd., 4121 W. 83rd St. Suite 108, Prairie Village, KS 66208

2. *Issues in Life Cycle Assessment*, Council on Packaging and the Environment, 1255 23rd St., NW, Washington DC 20037-1174

Paper or Plastic? Worksheet



Name ______________________________

ACQUISITION OF RAW MATERIALS, MANUFACTURING AND PROCESSING

To compare plastic and paper bags in terms of acquisition of raw materials, manufacturing and processing, use and disposal, we'll use data provided by Franklin Associates, a nationally known consulting firm whose clients include the U.S. Environmental Protection Agency as well as many companies and industry groups. In 1990, Franklin Associates compared plastic bags to paper bags in terms of their energy and air/water emissions in manufacture, use, and disposal. The following chart is a result of their study:

Life Cycle Stages	Air Emissions (pollutants) oz/bag		Energy Required BTU/bag	
	Paper	Plastic	Paper	Plastic
Materials manufacture, product manufacture, product use	0.0516	0.0146	905	464
Raw materials acquisition, product disposal	0.0510	0.0045	724	185

Raw Materials

a. Which bag would you choose if you were most concerned about air pollution?

____

b. If we assume that two plastic bags equal one paper bag, does the choice change? (Most shoppers use more plastic than paper bags.)

____

c. Compare the energy required to produce each bag. Which bag takes less energy to produce?

____

Distribution and Transportation

Another aspect of life cycle analysis is distribution and transportation. Considering that 1,000 paper grocery bags stack up to 46 inches, while 1,000 plastic bags stack up to 3.5 inches...

a. Which type of bag would require more trucks to transport?

____

b. How would this affect the amount of gasoline and oil used, and the amount of fuel-related pollutants created for paper bags?

____

____

____

____

Use and Reuse

As most of us know and practice, plastic and paper bags can be reused and recycled. Reuse and recycling are both important aspects of life cycle assessment.

a. List the variety of ways plastic bags can be reused.

____
____
____
____
____

b. List the variety of ways paper bags can be reused.

____
____
____
____
____

c. Which type of bag has more uses?

____
____
____
____
____

d. Does your community or local stores accept plastic bags for recycling?

____
____
____
____

e. How do you and your community recycle paper bags?

____
____
____
____

Recycling

It takes energy to recycle paper and plastic bags, and in the process, air pollutants are emitted. Again, the following information is provided by Franklin Associates. It compares the energy required (measured in BTUs) and the pounds of atmospheric pollutants generated when various percentages of paper and plastic bags are recycled.

	0% Recycled 100% Landfilled		**50% Recycled 50% Landfilled**		**100% Recycled 0% Landfilled**	
	Plastic	Paper	Plastic	Paper	Plastic	Paper
Number of sacks	60.8	30.4	60.8	30.4	60.8	30.4
Energy required to produce, MM BTUs	39.5	49.5	33.8	38.5	28.2	27.5
Atmospheric pollutants, lbs.	72.6	195.0	64.0	146.0	55.5	98.0

a. Compare energy per bag and recycling rates. Which bag requires more energy to recycle ?

b. How does the energy comparison between paper and plastic change between the 50 percent and 100 percent recycling rates?

c. Which bag produces more air pollution during the recycling process?

d. How does the pollution comparison between paper and plastic change between the 50 percent and 100 percent recycling rates?

e. How realistic is it to achieve a 100 percent recycling rate?

Disposal

a. Consider the stacks of paper and plastic bags used for the demonstration, and that 1,000 paper grocery bags stack up to 46 inches, while 1,000 plastic bags stack up to 3.5 inches. Which bag, paper or plastic, takes up less space in a landfill?

b. Fewer groceries are generally placed in plastic bags compared with paper. If we assume that two plastic bags are generally used in place of one paper bag, which bag would take up less landfill space?

c. Compare the relative weight of the two stacks. Which stack is heavier? By how much?

d. Data indicate that 1,000 paper sacks weigh about 140 pounds while the same number of plastic sacks weigh 15.6 pounds. Which kind of bag takes up more landfill space in terms of volume? In terms of weight?

Paper or Plastic? Answer Sheet

ACQUISITION OF RAW MATERIALS, MANUFACTURING AND PROCESSING

To compare plastic and paper bags in terms of acquisition of raw materials, manufacturing and processing, use, and disposal, we'll use data provided by Franklin Associates, a nationally known consulting firm whose clients include the U.S. Environmental Protection Agency as well as many companies and industry groups. In 1990, Franklin Associates compared plastic bags to paper bags in terms of their energy and air/water emissions in manufacture, use, and disposal. The following chart is a result of their study:

Raw Materials

a. Which bag would you choose if you were most concerned about air pollution? *Plastic*

b. Most shoppers use more plastic than paper bags. If we assume that two plastic bags equal one paper bag, does the choice change? *No*

c. Compare the energy required to produce each bag. Which bag takes less energy to produce? *Plastic*

Distribution and Transportation

Another aspect of life cycle analysis is distribution and transportation. Considering that 1,000 paper grocery bags stack up to 46 inches, while 1,000 plastic bags stack up to 3.5 inches:

a. Which type of bag would require more trucks to transport? *Paper*

b. What implications does this have in terms of gasoline and oil consumption and fuel emissions? *More trucks mean more fuel is consumed and more pollution and emissions are created.*

Use and Reuse

As most of us know, plastic and paper bags can be reused and recycled. Reuse and recycling are both important aspects of life cycle assessment.

a. List the variety of ways plastic bags can be reused. *Garbage bags, diaper bags, lunch bags, beach bags, rain protection, carry-all, etc.*

b. List the variety of ways paper bags can be reused. *Garbage bags, lunch bags, recycling bags, etc.*

c. Which type of bag is the most versatile? *Plastic*

d. Does your community or local stores accept plastic bags for recycling? *About 14,000 stores around the country do.*

e. How do you and your community recycle paper bags? *The most common way is through newspaper collection. The bags are used to hold the papers or they can be bundled in a bag.*

Paper or Plastic? Answer Sheet, con't.

Recycling

a. Compare energy per bag vs. recycling rate. Which bag requires more energy to recycle? *Generally, paper does.*

b. How does the energy comparison between paper and plastic change between the 50 percent and 100 percent recycling rates? *Paper becomes slightly more efficient than plastic*

c. Which bag produces more air pollution during the recycling process? *Paper*

d. How does the pollution comparison between paper and plastic change between the 50 percent and 100 percent recycling rates? *Paper still pollutes more, but the gap vs. plastic is closing.*

e. How realistic is it to have a 100 percent recycling rate? *Not very. The costs would be enormous! In fact, very few items without a deposit are recycled at a rate of 50% or above.*

Disposal

a. Consider the stacks of paper and plastic bags used for the demonstration, and that 1,000 paper grocery bags stack up to 46 inches, while 1,000 plastic bags stack up to 3.5 inches. Which bag, paper or plastic, takes up less space in a landfill? *Plastic*

b. Fewer groceries are generally placed in plastic bags compared with paper. If we assume that two plastic bags are generally used in place of one paper bag, which bag would take up less landfill space? *Plastic*

c. Compare the relative weight of the two stacks. Which stack is heavier? By how much? *Paper, by about seven times. See below.*

d. Data indicate that 1,000 paper sacks weigh about 140 pounds while the same number of plastic sacks weigh 15.6 pounds. Which kind of bag takes up more landfill space in terms of volume? In terms of weight? *Paper, in both cases*

Can We Really Reduce Our Cafeteria Waste?

CONTENT AREAS

- **Science**
  data collection and analysis
- **Health**
  nutrition

OBJECTIVES

Students will…

- scientifically survey and analyze the wastes produced in their school cafeteria
- design a plan to initiate and carry out source reduction for the cafeteria

MATERIALS

For each student and one for the entire class

- Cafeteria Trash and Waste Observations Data Table

TIME

Two periods
45 minutes each

One of the best places to get students to apply what they've learned about source reduction is in their own school lunchroom or cafeteria. Most likely, it's a place of obvious waste–with almost every student dumping food and packaging.

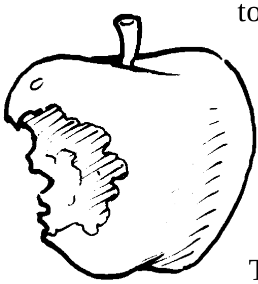
For this activity, your students will be able to collect significant data by surveying the waste habits of their peers. The activity is designed to last five days to ensure that the data collected will be fairly accurate.

To become familiar with the wastes in your cafeteria, you may wish to observe the lunchroom yourself before introducing the activity.

PART 1

Trash Detectives at Work

PROCEDURE



1. Inform students that they are all about to become Trash Detectives. For the next five days they will observe the waste habits of their peers during their lunch periods.

2. Provide each student with a copy of the Data Table–Cafeteria Trash and Waste Observations, for collecting their information. Students will use the table to record their observations of the trash habits of other students during lunch. As Trash Detectives, students will keep track of what students throw away or waste each day. The survey is simple and should not take more than a few minutes each day.

3. Keep a master data table in the classroom. Collate student data and display each day's results. You may want to copy this table onto posterboard.

4. At the end of the week, have students total their data. Then, as a class, determine a cumulative total and a cumulative ratio of trash items per student.

5. Discuss the survey results in terms of waste reduction. Have students devise a campaign to reduce the amount of cafeteria waste. Encourage students to use facts and figures as well as their creative ideas.

Here are some ideas and questions to get them started:

Questions

a. Do most students bring their lunch or buy the school lunch?

b. Did you notice any differences in type or quantity of waste generated by those who brought their lunch and those who bought it?

c. Is there one type of cafeteria food that students waste the most? The least?

d. What type of trash do students throw away the most? The least?

e. How will you introduce your idea? Morning announcements? Flyers? Posters? The school paper?

f. Was there more waste created by the students in the cafeteria or in the food preparation and service areas?

6. Have students present their plans to the class. Then as a class, use these ideas to develop a campaign against cafeteria waste. Make sure to involve school administrators, custodians and food service directors. To let students know if they are making a difference, use the same system as originally set up to collect data. Post the results in the cafeteria.

EXTENSIONS

1. Enlist the help of the school custodian or a member of the cafeteria staff to get an estimated volume and weight of a bag of cafeteria trash. How many bags does the cafeteria produce each day? What is the total weight of trash produced each day?

2. In some parts of the country, school cafeterias are buying milk in mini-sip pouches rather than cartons. Try to find out if they are available in your area. Research the pros and cons of using them, and then invite your Food Service Director to discuss the issue with your science class.

3. Have students discover the cost for the school to have its trash hauled away per month and year, and where the trash goes.

4. Challenge students to a Zero Waste Lunch Day, whereby students bring lunches that produce as little waste as possible. Some suggestions:

- Pack lunches in canvas or nylon bags
- If you use paper or plastic bags, reuse them
- Pack items in reusable containers
- Buy in bulk; avoid over-packaged foods
- Make or buy larger amounts of fruits, puddings, and chips, pack them in reusable containers
- Recycle bottles or use a thermos
- Reuse plastic silverware.

5. Invite the cafeteria staff to discuss source reduction and share students' ideas. Ask the staff to help implement students' plans to reduce cafeteria waste. Discuss other options to help reduce cafeteria wastes with such things as individual servings compared to self-service. Is it possible to have a self-serve bar for salad, fruit, rolls, and dessert?

DID YOU KNOW?

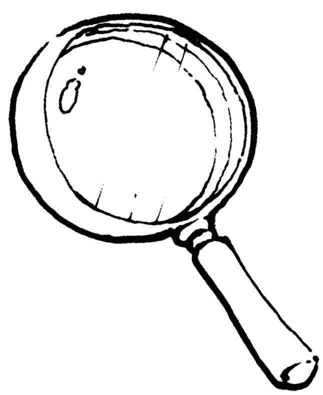
- Individual boxes of raisins cost 20 percent more and create 1,170 percent more garbage. Buy a two pound bag and package them in reusable containers.
- Individual bags of chips cost 30 percent more and create 1,220 percent more garbage. Buy large bags and pack them in plastic containers.

RESOURCES

For more information on lunch packaging, contact:

Polystyrene Packaging Council
1275 K Street, Suite 400
Washington, DC 20005

Foodservice & Packaging Institute
1901 N. Moore Street, Suite 1111
Arlington, VA 22209



The Great Disposable Debate

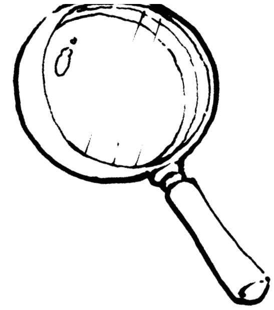
Once upon a time, school cafeterias washed their own dishes, trays and silverware. Today, many have switched to disposable items as a way to reduce costs and provide a more sanitary eating environment. Are the disposable items as environmentally friendly as their reusable counterparts?

Many studies suggest that the disposables may be a better choice, especially if schools do not currently have the equipment or space needed to effectively wash lunchroom items. Have your class debate the issue.

Remind them of the environmental costs of washing (use of water, chemicals and energy) as well as the costs related to disposables (increased landfilling, use of nonrenewable resources). Ask them to research the issue by contacting various government, industry and environmental groups. They should also talk to the school's Food Service Director.

Is there a clear answer? Challenge the class to find ways to reduce the impact of either system.

Cafeteria Trash and Waste Observations Data Table



	Day 1	Day 2	Day 3	Day 4	Day 5
	# Items	# Items	# Items	# Items	# Items
Number of students at my table					
Paper					
Foil					
Cans					
Bottles					
Juice Boxes					
Milk Cartons					
Plastic					
Food Scraps					
Other(s) Item 1					
Item 2					
Item 3					
Item 4					
Item 5					
Item 6					
Item 7					

The Great Paper Waste

CONTENT AREAS

- **Math**
  calculations
- **Social science**
  resources
- **Language arts**
  writing

OBJECTIVES

Students will…

- examine their habits and calculate how much paper waste they generate
- determine what they can do to minimize paper waste
- determine some alternatives to paper products and analyze the advantages and disadvantages
- understand that recycling is good, but not as good as source reduction

MATERIALS

For each student

- The Great Paper Waste Worksheet

TIME

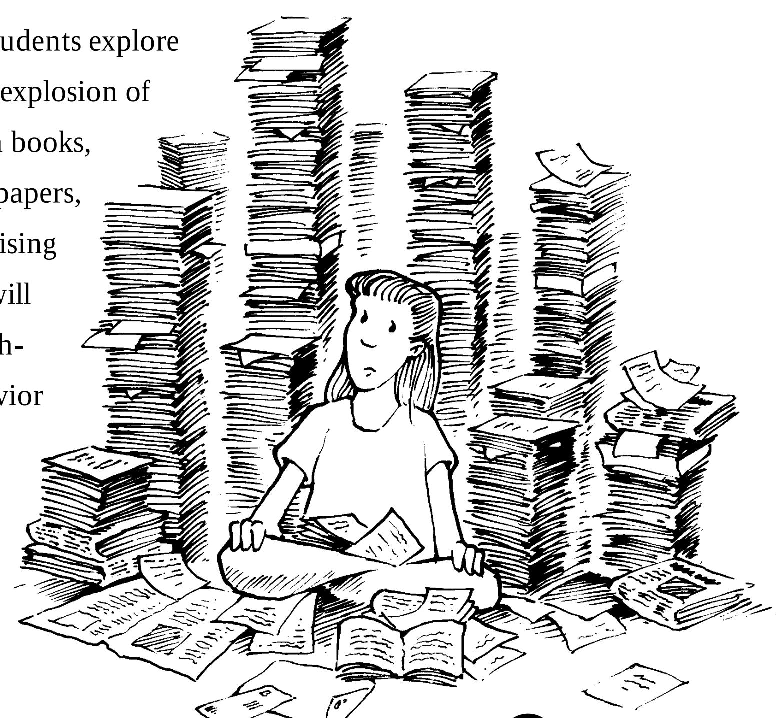
Two periods

45 minutes each

We depend on paper so much that it is creating a serious waste disposal problem. In fact, paper is the largest category of municipal solid waste. Each year, about 78 million tons of paper and paperboard are generated, or about 560 pounds for every person in the United States.

Won't recycling take care of the problem? Unfortunately, not all paper and paper products can be recycled, and not everything that is recyclable is being recycled. Frankly, just because we recycle paper doesn't mean we shouldn't first think about reducing its use. Recycling can end up using more energy resources than paper made with new paper pulp–it requires labor and resources for collecting, sorting, transporting, de-inking, and milling–a very expensive process. Also, it's not uncommon for 25 percent of the paper collected for recycling to end up as waste once it gets back to the paper mill.

In this activity, students explore the causes of the explosion of paper waste from books, magazines, newspapers, paper and advertising materials. They will consider how technology and behavior can work to reduce paper waste at school, home and the office.



PROCEDURE

1. Ask students to list all the ways they use paper each day. Briefly discuss their lists.
2. Read the introduction of *The Great Paper Waste* worksheet to the students or have them read it.
3. Have students complete the first section of the worksheet. When they are finished, use the following exercise to prove how large of a problem paper waste is. Ask each student for his or her estimate of daily paper use. Total all students' estimates. Divide the total by the number of students in the class to obtain an average number of sheets of paper each student uses in a day. Multiply the average by the number of students enrolled in your school. To convert the figure from sheets of paper to pounds of paper, divide by 145 (or have students calculate the figure themselves). To make the point even more dramatic, go on to calculate paper use over a week, month or year.
4. Make a list on the overhead or board of ways to reduce paper use. At this point, students should be responding that reducing is better than recycling. Make it clear that reusing and recycling are certainly better than throwing away, but we should try to reduce first.
5. Have students work with partners to complete the sections "Other Types of Paper Products" and "At the Office." You may want to discuss students' ideas as a class or pair up teams to share responses.
6. The last question, "What Can You Do?" should be used for closure. The students should individually write down three things they are capable of doing to use less paper.

QUESTIONS:

a. What did you discover by doing this activity?

b. What surprised you the most? Why?

EXTENSIONS

1. Call local companies and ask if they have a policy to reduce office waste paper. (Examples of paper-saving efforts include copying on both sides, limiting the copies produced by routing single copies to multiple parties, and using electronic mail.) List the companies that do, what the policy is, how long it has been in effect and the projected savings in pounds of paper and dollars (if known). Share the results with the class and the companies.
2. Research what is done with old phone books in your community. Are they recycled? by whom? how many? for what? Wouldn't it be better not to send phone books to people who don't need them? What policies does your local phone company have on distribution of phone books?
3. Have students develop a way to communicate the need to use less paper—*no paper allowed!*

DID YOU KNOW?

Companies must strive to produce goods using fewer resources in order to be competitive. AT&T estimated that by adopting a double-sided copying policy, they would save 77 million sheets annually and save $385,000 a year. This would happen if the policy were followed only half the time!

Encyclopedias on CD-ROM are another example of this type of source reduction. They are up to date, more colorful, include sound, and use fewer materials. They ultimately cost much less to produce and to sell as well.

Answer Sheet: The Great Paper Waste

PART 1

My Paper Use

For questions 1 to 4, check students' answers to see if they are reasonable and thoughtful.

For questions 5 and 6, check students' math.

For questions 7 and 8, students should be responding that reducing is better than recycling, and that not everything that *can* be recycled *is* recycled.

PART 2

Other Types of Paper

1. Some of the items and alternatives that could be included in the paper products chart are listed below.

▪ Junk Mail: Send unwanted mail back to the source and ask that your name be taken off the mailing list.

▪ Write to the Mail Preference Service, a no-charge service that removes names from national mailing lists. Send your name and address and any spelling variations you have noticed on mailing labels to:

Mail Preference Service
Direct Marketing Association
11 West 42nd Street
P.O. Box 3861
New York, NY 10163

▪ Books: Check books out from the library, trade with friends, use book exchange, sell.

▪ Magazines: Check out from library, trade with friends, subscribe only to ones you read regularly.

▪ Phone books: Get only one new phone book each year; use the old one by a second phone.

▪ Newspapers: Read office, library or school copy, share with neighbor, watch news, access computer bulletin board service news.

▪ Encyclopedias: Use CD-ROM encyclopedias, library encyclopedias, or encyclopedias on computer service bulletin boards.

▪ Office paper: Use computer disks and modems; circulate one memo.

▪ Bags and sacks: Reuse them for small purchases or bring your own bag.

▪ Tissues and paper towels: Use cloth towels and handkerchiefs.

It will take a few months before you notice a decrease. Unfortunately, this won't affect junk mail from local sources. You'll need to write directly to these mailers and ask that your name be removed from their lists.

2. The advantages of these alternatives to paper use include economic savings and less paper use. The disadvantages are inconvenience and need for special equipment.

3. You could do a report by using a CD-ROM encyclopedia or accessing magazine articles through a computer, writing the report on a disk, and turning the disk in to the teacher.

4. The advantages of a CD-ROM encyclopedia are that the disks are small, do not use paper, are easier to use and update, cost less than a set of encyclopedias, and may have sound and video as well as text and pictures.

5. and **6.** Students may have many different ideas. Accept all ideas.

PART 3

At the Office

1. Copy machines and computers have made it easy to copy and generate papers. Because it is easy to change wordprocessed documents, they are frequently changed and new ones are printed. Photocopy machines are probably the largest contributor to the problem–people can make multiple copies of documents quickly and easily. Photocopiers and printers may also cause some paper loss through technical problems.

2. The following are some technologies, with their advantages and disadvantages.

- Computer: Stores information that can be read on screen; expensive; need training; must have a computer to read information stored on disk.
- Modem: Permits information to be transmitted through a computer; can use electronic mail; needs computer, modem, access line.
- Computerized phone: Can store messages; need special equipment.
- Computer bulletin board service: Can send and receive information electronically; must pay for service.

3. Office workers can copy on both sides; use E-mail; reuse "scratch" paper.

4. Teachers can use both sides of a paper; use classroom sets of papers (when appropriate) rather than one for each student; can use and encourage students to save paper printed on one side and use back for scratch paper.

The Great Paper Waste Worksheet

Name

Imagine a day without paper. No books, no notebook paper, no magazines, no paper of any kind. How would you feel about that? Before some of you start celebrating class without books and no paper for assignments, think about not having paper to write your friends juicy gossip, no motorcycle magazines, no drawing paper to draw cartoons in your most boring class. For better or worse, we all depend on paper… a lot.

We depend on paper so much that it's creating a real waste disposal problem. In fact, paper is the largest category of solid waste. Each year about 78 million tons of paper and paperboard are generated, or about 560 pounds for every American.

Won't recycling take care of the problem? Unfortunately, not all paper and paper products are recyclable, and not everything that is recyclable is being recycled. Frankly, just because we recycle paper doesn't mean we shouldn't first think about reducing its use. Recycling can end up using more energy resources than paper made with new paper pulp—it requires labor and resources for collecting, sorting, transporting, de-inking, and milling the paper—a very expensive process. Also, it's not uncommon for 25 percent of paper that is recycled to end up as waste once it gets back to the paper mill.

As you can see, even after recycling, we're left with a lot a paper, books, and magazines that are sent to waste facilities. As individuals, what can we do to reduce this flood of paper?

Let's start by taking a look at our own paper use.

PART 1

My Paper Use

1. About how many pieces of paper do you use at home and at school each day?

_________________ pieces

2. Think about all those pieces of paper. What were they for? Write them down on the list. Then write down how you could have reduced the amount you used.

What I use paper for

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

5. ______________________________

How could I have reduced the amount used?

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

5. ______________________________

____

3. Had any of the paper been used before?

____

4. How many pieces of paper could you have saved by using paper that had already been used on one side, by using both sides of your paper, or by being more careful about wasting paper?

_________________ sheets of paper saved

5. Multiply that number by the average number of school days in a month (24).

How many sheets would you have saved?

_________________ sheets saved per month

6. Now figure out how many pounds of paper waste you will save in a year. There are 145 sheets of paper to each pound.

_________________ pounds of paper saved

7. In addition to reducing waste, why else should you try to reduce the amount of paper you use?

____

____

____

____

____

____

____

8. What about recycling? Did you recycle every recyclable paper? If not, why not?

____

____

____

____

____

____

____

PART 2

Other Types of Paper Products

1. According to the EPA, paper accounts for 38 percent of waste generated, or 78 million tons yearly. The biggest factor is corrugated boxes, which create 26 million tons of waste yearly. Second is newspapers, accounting for 13 million tons. These are followed by office paper, 7 million tons; commercial printing, 5 million tons; folding and milk cartons, 5 million tons; third class mail, 4 million tons; and tissues and paper towels, 3 million tons. Think of any alternatives that could be used to reduce waste or eliminate the use of these and other paper products.

Paper Products	Alternatives
Corrugated boxes	
Newspapers	
Office paper	
Commercial printing	
Milk cartons	
Junk mail	

Paper Products	Alternatives
Tissues	
Paper towels	
Magazines	
Bags and sacks	
Books	
Paper plates and cups	
Telephone books	

2. What are some of the advantages and disadvantages of these alternatives?

3. Describe how you could do a report and turn it in without ever using any paper.

4. In the last few years, as CD-ROMs have become more widespread, new forms of software have been developed that not only take advantage of this interactive form of media, but also replace more traditional forms of paper items. Today, you can find textbooks, dictionaries, cookbooks, and encyclopedias on CD-ROM. Suppose you were required to do a report using a CD-ROM encyclopedia instead of the traditional bound volumes. What would be the advantages and disadvantages of the CD-ROM encyclopedia? List your answers:

Advantages of CD encyclopedias

Disadvantages of CD encyclopedias

5. Think about this activity, which requires every student to use several sheets of paper. How could you do it without using paper?

6. Phone books are a big waste problem. Many are shipped to Asia for use in building products. But, they are still a big problem. Is it possible to eliminate the need for phone books? Don't forget that many companies depend on phone book advertising to get customers.

PART 3

At the Office

1. The advances in office technology over the last 20 years–from photocopy to FAX machines–have resulted in an explosion in office waste paper. Between 1972 and 1987, office paper as a waste category increased by 130 percent. Why has paper waste increased with all this new technology? List your ideas below.

2. What types of technology would reduce the need for office paper? List them on the chart along with advantages and disadvantages of each.

Technology	Advantages	Disadvantages

3. What can be done to reduce the amount of office paper waste?

4. What could teachers do to reduce the amount of paper they use?

PART 4

What Can You Do?

Write down three things you could do to reduce wastepaper.
Then make a poster for your room that helps you remember them.

1.

2.

3.

The Decision Makers

CONTENT AREAS

- **Math**
  percentages, pie-chart graphs, volume, ratios
- **Social studies**
  business, industry, community
- **Science**
  solid waste, prediction, classification, measurement of weight and volume, verification

OBJECTIVES

Students will…

- read, understand and analyze information about trash, and
- make informed decisions about source reduction

MATERIALS

For students working in groups of two or three

- Instruction Sheet
- Decision Grid handout
- Charts 1 to 4
  (See Materials, Curriculum Guide)

TIME

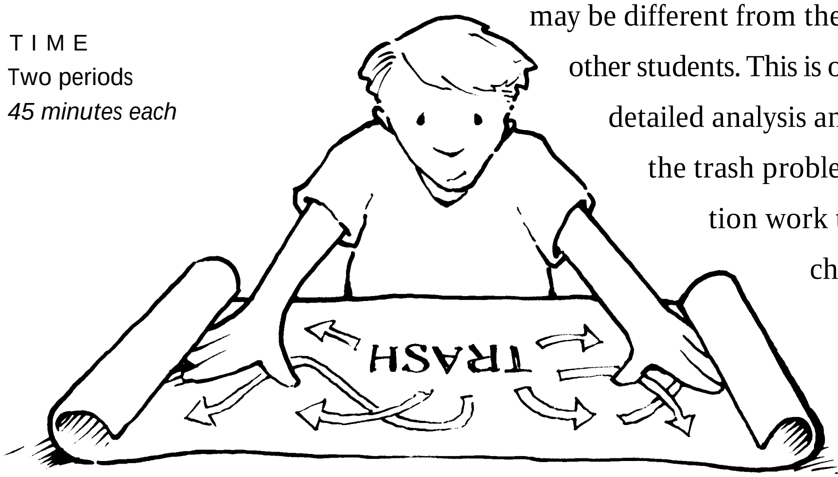
Two periods
45 minutes each

Information is an essential factor in decision making. Some say it is the key to the future. The real key may be knowing where to get reliable information, how to understand and analyze it, and then how to use it.

Information is also crucial to understanding trash and solving related problems. In this activity, students are presented with some information–primarily facts about trash. Through a series of steps, they use this information to direct and develop a strategy for source reduction.

These steps are loosely based upon a complex strategy that product designers, businesses, local and state officials, and other decision makers use to make choices about source reduction. Your students will be asked to make choices about source reduction. Some choices may be difficult, others may be obvious. What is most important is that students use the information to help make their choices.

Just as various decision makers may interpret and use the information according their interests, students' answers may be different from the "experts," from your own, or other students. This is okay, because what counts is detailed analysis and creative thinking. Solving the trash problem and making source reduction work takes thought, new ideas, choices and, finally, action.



PROCEDURE

1. Divide students into groups of two or three. *Read them the following scenario:*

Landfills and incineration have become very controversial issues in your state, and the Governor has pledged to make the environment a top priority. Although recycling efforts have been in place for some time, the state can no longer afford to pay ever-higher rates for resource recovery.

The key goal set by the Governor is to reduce the total state waste that's now sent to landfills and incinerators by 10 percent. This would be a reduction of approximately 1.5 million tons from the 15 million tons currently burned or dumped annually. Since it costs about $40 per ton to landfill waste, the program could save $60 million if the reductions occur through source reduction. The Governor is willing to budget the money needed to accomplish the objective, using some of the savings to fund the program.

The Governor has turned to you, a waste expert, to help come up with a plan to solve the state's most critical waste problems. You will be working as part of a team to develop the plan, which you must present to the Governor for approval. Specifically, your team is asked to:

- Develop a list of priorities
- Explain why you chose the priorities
- Provide a list of source reduction options for each priority.

2. Give each student or group a copy of the Instruction and Trash Trivia Sheet, Charts 1–4 (from the Curriculum Guide) and the Decision Grid. Using the Charts, groups should lay out options on the Decision Grid. They can then prioritize their options based upon any factors they feel are appropriate.

3. This activity is student-directed and requires focused collaboration. As students work to complete the activity, be on hand to answer questions and facilitate discussion. You may also need to provide additional resources on solid waste and source reduction for students to do additional research.

4. When all groups are finished, have each group present its plans. Encourage students to be convincing and creative in their presentations. You may want to allow for a short question-and-answer period at the end of each presentation.

QUESTIONS

Follow the activity with a class discussion

a. Is it possible to develop a qualitative way to prioritize areas targeted for source reduction?

b. How did you determine your priorities?

c. Do all of the criteria have relative weight?

d. What makes your plan effective?

e. What was most important in coming up with a solution?

f. Did you verify the facts? How? What role did the fact sheet play in your decision making? What if the facts were incorrect?

g. Plans look good on paper. Is it possible for your plan to be implemented in the real world? Why or why not?

h. Did you make any plans to verify the current trash situation and measure the effectiveness of your plans?

EXTENSIONS

1. The Governor is sold on your plan. Now he wants to implement legislation and again needs your advice. Which options should become mandatory laws? Which should remain as voluntary actions? Explain your reasons.

2. Contact your community or state government and find out what strategies they have used to handle the trash problem. What are their priorities?

Remind students that if they propose legislative solutions based on bans (prescriptive approaches), this can take away the possibility of creative solutions that evolve over time. Also they must take into account all types of families from the poor to rich, urban and rural. Very few mandates are fair to all people. For example, banning disposable diapers may seem like a quick fix for one percent of trash, but would be a severe blow to working mothers whose children are in day care centers, since most day care centers insist on disposable diapers for health reasons.

By the year 2000...

Containers and packaging currently comprise the largest portion of the waste stream, 34 percent by weight. However, packaging's share of the waste stream is slowly declining, so that by the year 2000, it will comprise about 30 percent of the waste stream. Because of household growth in the state, 0.5 million tons of trash is expected to be added to the total each year. That's the bad news. The good news is that existing recycling programs around the state are also expected to grow at a rate of 0.5 million tons a year, at no additional cost.

Nondurable goods are projected to become the largest category of municipal solid waste by the year 2000. Nondurables are expected to grow from a 27 percent share by weight in 1995 to a 32 percent share by weight. Nondurable goods are defined as having a life span of less than three years. This category includes newspapers, books, magazines, office paper, advertising materials, disposable diapers, and clothing. Products increasing the most are paper products, especially books, magazines, office paper, and advertising.

Source: Franklin Associates Ltd., Analysis of Trends in Municipal Solid Waste Generation, 1962 to 1987, January 1992.

Instruction Sheet: The Decision Makers

Landfills and incineration have become very controversial issues in your state, and the Governor has pledged to make the environment a top priority. Although recycling efforts have been in place for some time, the state can no longer afford to pay ever-higher rates for resource recovery.

The Governor has turned to you, a waste expert, to help come up with a plan to solve the state's most critical waste problems. You will be working as part of a team to develop the plan, which you must present to the Governor for approval. Specifically, your team is asked to:

1. Develop a list of priorities,
2. Explain why you chose the priorities, and
3. Provide a list of options for source reduction for each priority on your list.

Before you prepare your plan, you must be well informed. In this activity, you are presented with some information–primarily facts about trash. Through a series of steps, you will use this information to direct and develop a strategy for source reduction.

1. Understand the information.
2. Analyze the information.
3. Use the information to develop a positive solution.

These steps are a simple version of a complex process that product designers, businesses, local and state officials, and other decision makers use to make choices about source reduction. You, too, will be asked to make choices about source reduction. Some may be difficult, while others are obvious.

What is most important is that you use the information to help make your choices. Just as various decision makers may interpret and use the information based on their interests, your answers may be different from the "experts," your teacher, or other students.

This is okay, because what counts is detailed analysis and creative thinking. Solving the trash problem and making source reduction work takes thought, new ideas, choices and, finally, action.

Understand the Information

Students work individually

1. **Read –** Carefully read and study Charts 1 through 4 and the Trash Trivia, below. Although there seems to be only a list of facts, the sum of the information tells you something about the current trash problem as well as future trends.

   Note: Your state's trash problem is a mirror of the country's problems.

2. **Write –** Using the information in the Data Sheets and Trash Trivia, write a one-to two-page summary of what you believe to be the state's largest and most critical trash problems and how source reduction could help solve them.

Analyze the Information

Students work in groups

3. **Report –** Share your written summaries and explain your positions to each other.

4. **Brainstorm –** Use the Decision Grid to develop a list of priorities. You may use the EPA Data Sheets as a guide.

5. **Evaluate –** For each priority, list its current contribution to the waste stream and the amount by which you expect to reduce its contribution. Explain why you feel this savings will be realistic. Again, the Data Sheets will help you. You may need to go to the library to do more research.

6. **Prioritize –** In examining the overall trash problem, try to rank the priorities for source reduction. What is the best way to use the criteria to determine the ranking?

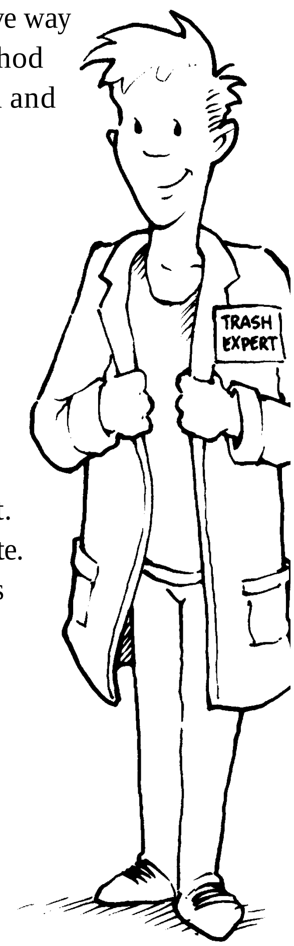
Use the Information to Develop a Plan

7. **Decide –** Using what you've learned so far about various source reduction strategies, think of appropriate options to reduce each of the priorities.

8. **Compare –** Compare the completed grid with your written summaries. Does the grid support your arguments?

9. **Write –** Use the grid and your original summaries to develop a plan for source reduction. Explain what your priorities are and why. In your plan, describe strategies that individuals, businesses, and industries would each use to reduce each priority.

10. **Present –** Here's your chance to use your creative skills and think of an effective way to present your plan. Think of a method that catches the Governor's attention and will "sell" your plan's merits.



Trash Trivia

Different Rates of Growth for Different Materials

Between 1972 and 1987, the number of households in the United States (and in your imaginary state) grew by 34 percent. Solid waste increased at about the same rate. But not all kinds of waste increased at this rate:

- Office paper increased 130%
- Books and magazines increased 84%
- Appliances increased 48%
- Newspapers increased 21%
- Tires increased 15%
- Food packaging increased 7%
- Beer and soft drink cans decreased 29%

Decision Grid

Item	% share of waste stream	Is it a growing problem?	Is it toxic?	*Priority	Options for source reduction

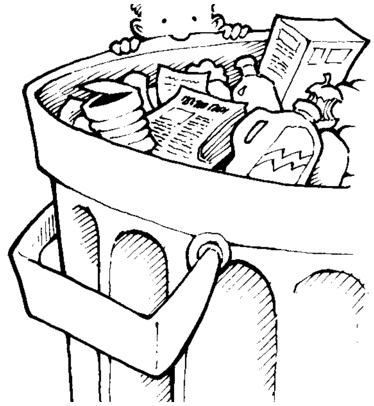
***Priority Ranking system**

1 = high
2 = medium
3 = low
? = not known

An Ounce of Prevention

MIDDLE LEVEL SCIENCE CURRICULUM
ON SOURCE REDUCTION

Quiz



Name ___

Let's find out exactly what we've learned about waste prevention. Here are 10 questions (8 points each) taken from *An Ounce of Prevention* and two brief essays (10 points each).

1. The largest single item found in landfills is:

a. Paper

b. Plastic

c. Yard wastes

d. Food

2. To find the volume of a particular material, you multiply its:

a. Length, height and density

b. Length, width and density

c. Length, width and height

d. Length, height and density

3. There are four ways to handle garbage once it is generated. They are:

a. Compaction, recycling, landfilling and degradation

b. Composting, recycling, incineration and landfilling

c. Compaction, recycling, incineration and landfilling

d. Chopping, slicing, dicing and shredding

4. It gets harder and harder to find sites for new landfills. The problem goes by the name "the NIMBY Syndrome." What does NIMBY stand for?

N__________ I____________ M__________

B__________ Y____________

5. Which two items are recycled most frequently?

a. Shoes and socks

b. Corrugated boxes and aluminum cans

c. Newspapers and aluminum cans

d. Steel cans and glass bottles

6. To discover the density of an item, you divide its mass by its:

a. Weight

b. Size

c. Specific gravity

d. Volume

7. Which statement is most true about packaging:

a. It serves no valuable purpose.

b. It is not a solid waste problem.

c. It serves a valuable purpose but is a large part of our waste.

d. It serves no valuable purpose and is a large part of our waste.

8. While recycling is a positive step, it uses energy and resources and creates pollutants. To conserve resources and minimize waste, which of these strategies should be considered before recycling?

a. Incineration

b. Source reduction

c. Incineration and source reduction

d. None of the above

9. Reducing hazardous waste is one of the primary objectives of source reduction. Draw a line to match the potentially hazardous product on the left with its more "environmentally friendly" counterpart on the right.

drain cleaner	**natural acids such as lemon juice, sour milk**
plant sprays	**cedar chips**
mothballs	**plunger**
rug cleaner	**mild soap and water**
metal polish	**club soda**

10. Analyzing all of the material, energy and pollution factors that go into the production, transportation and disposal of an item is referred to as

____

____

Essays

(Write your answers on a separate sheet of paper.)

1. Why is it better to reduce first and then recycle?

2. You decide to buy a new pair of sneakers. From a Life Cycle Analysis (LCA) view, what steps go into making these shoes and what resources are used?

Answer Sheet

Name

Let's find out exactly what we've learned about waste prevention. Here are 10 questions (8 points each) taken from *An Ounce of Prevention* and two brief essays (10 points each).

1. The largest single item found in landfills is:

a. Paper

b. Plastic

c. Yard wastes

d. Food

2. To find the volume of a particular material, you multiply its:

a. Length, height and density

b. Length, width and density

c. Length, width and height

d. Length, height and density

3. There are four ways to handle garbage once it is generated. They are:

a. Compaction, recycling, landfilling and degradation

b. Composting, recycling, incineration and landfilling

c. Compaction, recycling, incineration and landfilling

d. Chopping, slicing, dicing and shredding

4. It gets harder and harder to find sites for new landfills. The problem goes by the name "the NIMBY Syndrome." What does NIMBY stand for?

Not *In* *My*

Back *Yard*

5. Which two items are recycled most frequently?

a. Shoes and socks

b. Corrugated boxes and aluminum cans

c. Newspapers and aluminum cans

d. Steel cans and glass bottles

6. To discover the density of an item, you divide its mass by its:

a. Weight

b. Size

c. Specific gravity

d. Volume

7. Which statement is most true about packaging:

a. It serves no valuable purpose.

b. It is not a solid waste problem.

c. It serves a valuable purpose but is a large part of our waste.

d. It serves no valuable purpose and is a large part of our waste.

Answer Sheet

8. While recycling is a positive step, it uses energy and resources and creates pollutants. To conserve resources and minimize waste, which of these strategies should be considered before recycling?

a. Incineration

b. Source reduction

c. Incineration and source reduction

d. None of the above

9. Reducing hazardous waste is one of the primary objectives of source reduction. Draw a line to match the potentially hazardous product on the left with its more "environmentally friendly" counterpart on the right.

drain cleaner	**natural acids such as lemon juice, sour milk**
plant sprays	**cedar chips**
mothballs	**plunger**
rug cleaner	**mild soap and water**
metal polish	**club soda**

10. Analyzing all of the material, energy and pollution factors that go into the production, transportation and disposal of an item is referred to as

Life Cycle Analysis

Essays

(Write your answers on a separate sheet of paper.)

1. Why is it better to reduce first and then recycle?

Students should write about facts like these:

• *Reducing conserves energy and resources while reducing pollution*

• *Reducing is preventive*

• *Recycling is a process that consumes resources and creates pollution*

2. You decide to buy a new pair of sneakers. From a Life Cycle Analysis (LCA) view, what steps go into making these shoes and what resources are used?

• *Growing cotton for fabric uses water, pesticides, fertilizers, fungicides, fuel for tractors, etc.*

• *Processing gas and oil to make synthetic rubber soles*

• *Transporting materials, which uses fuel and creates pollution*

• *Dyes used to color the fabric*

• *Electricity used to sew fabric and soles together*

• *Shoes packaged in tissue and cardboard boxes, which come from paper mills and trees*

• *Shoes transported to warehouses, stores, and homes–uses energy and creates pollution*