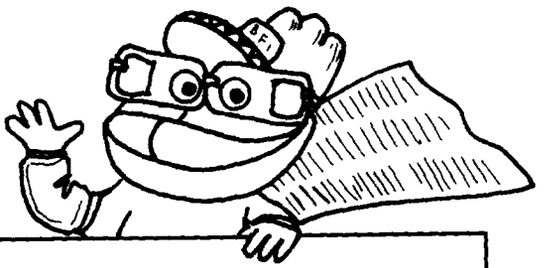
Browning-Ferris Industries'

MOBIUS® Curriculum: Understanding the Waste Cy

Third Edition



Browning-Ferris Industries' MOBIUS® Curriculum: Understanding the Waste Cycle

A Recycling and Environmental Education Curriculum for Grades 4 Through 6
Third Edition

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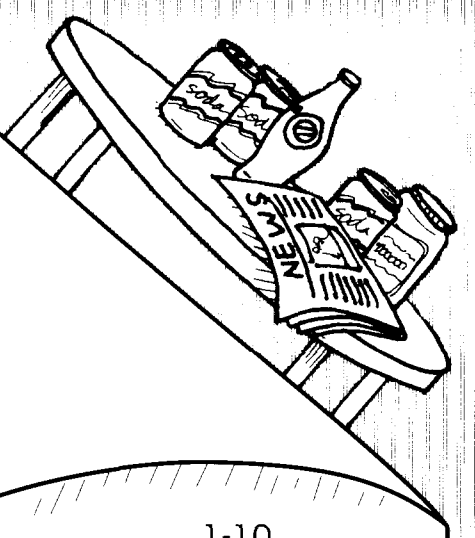
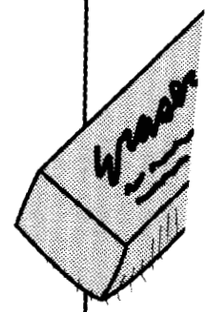


Dear Educators,

Welcome to the Third Edition of **Browning-Ferris Industries' MOBIUS Curriculum: Understanding The Waste Cycle** for grades four through six. The lessons and activities are designed to help you teach your students to become better environmental citizens so that they can learn to play an active role in dealing with waste issues, from reduction to disposal.

Each chapter includes a chapter summary, a clear, concise statement of objectives, an outline, an explanation of the concepts and skills addressed, the materials needed and the procedure to follow, plus complete teacher-background information on all the subjects covered.



The most current information available covers all the major methods for managing the waste stream from landfills to waste-to-energy to composting, with special emphasis on "The New 3 R's: Reduce, Reuse and Recycle," because these are ways each of us can make a significant difference in "taming the waste stream."

Whether you are involved in individual or team teaching, you'll find the chapters easy to integrate into your current curriculum and to apply in a variety of subject matter areas, including math, science, social studies, language arts and fine arts. The "hands-on" nature of the curriculum also makes it particularly suited to "whole language" learning experiences.

We attribute the success of the Mobius Curriculum to the fact that it is "teacher-driven." During its development, selected teachers from across North America contributed their ideas and tested the effectiveness of the lessons in the classroom. Their early assistance and the ongoing feedback we receive from participating teachers has helped assure its continuing integrity.

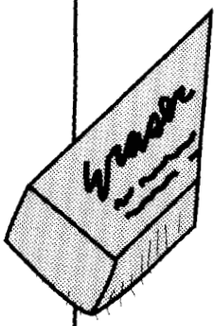
Throughout the curriculum, you'll meet Mobius, a special mascot, who serves as a fun-loving guide for the children as they study their lessons. (The colorful cartoon story, "A Conversation with Mobius," in the packet of materials in the back of this binder, will tell you more about the character and help you introduce Mobius to your students.)

over

Page Two
Letter to Educators

The character, created from five of the major recycling elements, is now more than a drawing; Mobius has become a famous "live" personality who has traveled throughout North America making personal appearances at schools, community events, recycleries, and even at the White House Annual Easter Egg Hunt.

The popularity of Mobius and of the Mobius Program continues to grow. By 1995, copies of the curriculum had been donated to the Peace Corps for use in 87 underdeveloped countries, world-wide, and more than 15,000 classroom teachers in the United States and Canada were participating in the program. We are pleased that you join them in recognizing the importance of sound environmental education for our children.



The future of our planet will someday rest on the shoulders of the children you are now teaching. By understanding the importance of an integrated waste disposal system and The New 3 R' s, your students will learn that through their own actions they can make a positive difference in the world. Perhaps this is the Mobius Curriculum's most valuable lesson.

Sincerely,

Browning-Ferris Industries

Note to teachers:
To conserve paper, most curriculum pages have been printed on both sides.
Please photocopy the following letter and ask students to take it home to their parents before you begin your teaching unit(s).
(Please explain to your students that the availability of recycling centers and curbside collection programs varies widely in different parts of the country. One of the assignments, during your course of study, is to find out what recycling opportunities exist in your community.)

Dear Parent:

Your child is participating in a school curriculum to learn about the importance of an integrated solid waste disposal system, which includes recycling, composting, waste-to-energy, and landfilling. The program is sponsored by Browning-Ferris Industries (BFI), one of the world' s largest recycling and solid waste services companies.

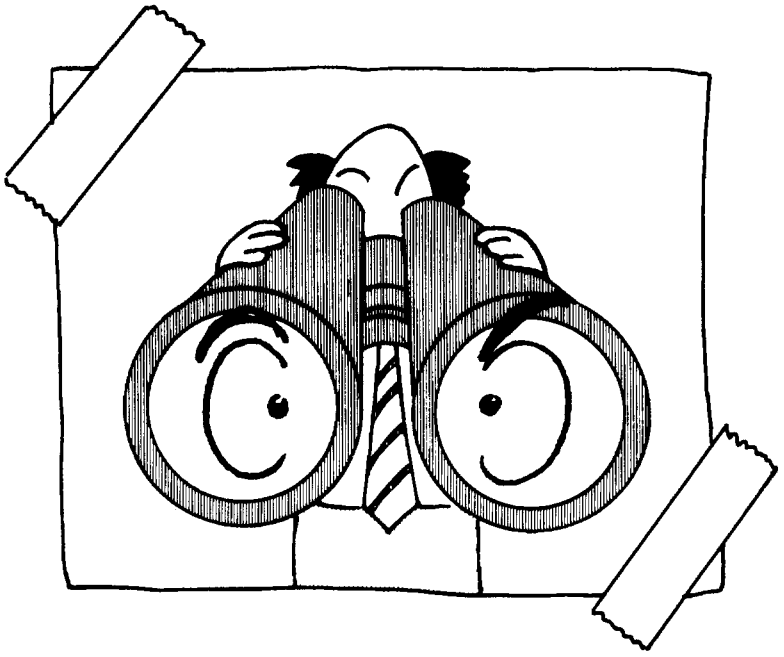
The **Browning-Ferris Industries' MOBIUS Curriculum: Understanding The Waste Cycle** has been developed to provide up-to-date, professional materials on all the current methods of managing waste. Special emphasis has been placed on "The New 3 R' s: Reduce, Reuse and Recycle" since these are ways each of us can make a difference in "taming the waste stream."

Each American generates approximately 4.4 pounds of waste each day. Adding commercial and industrial waste to this total only raises the average. The United States generates over 207 million tons and discards over 162 million tons of municipal solid waste annually. The problem of how to manage our waste is serious and must be addressed immediately.

Reducing, reusing and recycling are **part** of the solution. We can **reduce** waste by avoiding products that are excessively packaged or are for single-use only. We can **reuse** waste by finding other uses for items we would normally throw away (tin foil, plastic bags, shoe boxes, etc.), and we can **recycle** waste by separating our recyclable materials, such as paper, metals, glass and plastic, from other trash and taking our recyclables to a recycling center or participating in a curbside recycling program when these resources are available in our community. Other parts of the waste solution include using waste as fuel to produce energy and composting leaves and other organic materials.

We encourage you to support your child' s efforts to learn about managing the waste stream. Environmental education will help create a better world for you and your children, and for the generations to come.

Sincerely,



Teacher Overview

MOBIUS Curriculum Objectives

- To introduce students to solid waste management systems and the problems that arise when waste is not managed effectively
- To help students learn the cyclical nature of our environment
- To teach The New 3 R's of the solid waste disposal solution: **Reduce, Reuse, Recycle**
- To encourage students to participate in creative individual and community-wide solutions to the solid waste disposal problem

Subjects Addressed

Science, Social Studies, Mathematics, Language Arts, Fine Arts

The world is facing an ever-increasing solid waste disposal problem. The amount of solid waste we produce is escalating. When improperly handled it poses a threat to our environment. But there are solutions to this problem if everyone participates.

The solid waste disposal problem involves all of us. According to recent studies, every person in North America generates 4.4 pounds (2 kilograms*) of waste daily. United States residents generate more waste than any other country - 207 million tons (188 million metric tons) and discard over 162 million tons (147 metric tons) annually. But, the United States is not alone. According to the Environmental Industry Associations, Canadians produce nearly as much waste per capita as do U.S. citizens.

Among the methods of waste disposal in the United States and Canada are: burying waste in **sanitary landfills** and burning it in **waste-to-energy plants** or incinerators. Sanitary landfills, which have replaced open dumps, have helped keep our environment safe; waste-to-energy plants are designed to burn cleanly and generate energy for municipalities and private utilities. However, waste-to-energy plants and **incinerators**, while they significantly reduce the amount of waste in landfills, are comparatively more expensive and still require landfills for disposal of ash residue.

Solutions to the solid waste disposal problem can only be found in an integrated system. No single method will work. Among the integrated measures needed to solve the problem are the following:

- **Waste reduction:** With an estimated 29.4 percent by weight and 32.1 percent by volume of U.S. trash that is discarded comprised of packaging, consumers are encouraged to buy products using environmentally sound packaging. To influence marketers, look for and use products made from and packaged in recycled and recyclable materials. Good examples of recycled materials in packaging include breakfast cereal boxes, egg cartons, shoe boxes, beverage cans, and glass jars. If a box is gray inside when you tear it, it's probably made of recycled paper.
- **Waste reuse:** By reusing items instead of throwing them away, we find valuable uses for these materials. Examples include repairing appliances instead of buying new ones.

* In most cases throughout the curriculum, metric equivalents have been rounded to the nearest whole number.

• **Composting:** Composting **organic** materials, such as yard waste, creates humus; rich, partially decomposed organic matter that can be used as a soil additive.
• **Recycling:** Recycling materials such as paper, metals, glass, tires, and certain plastics can reduce the solid waste sent to landfills by up to 25 percent.
• **Waste-to-energy:** Burning waste in environmentally safe waste-to-energy plants produces useful energy for surrounding communities.
• **Sanitary landfills:** There will always be waste that cannot be reduced, reused, or recycled. This volume can be disposed of safely in strictly regulated, well-engineered sanitary landfills.

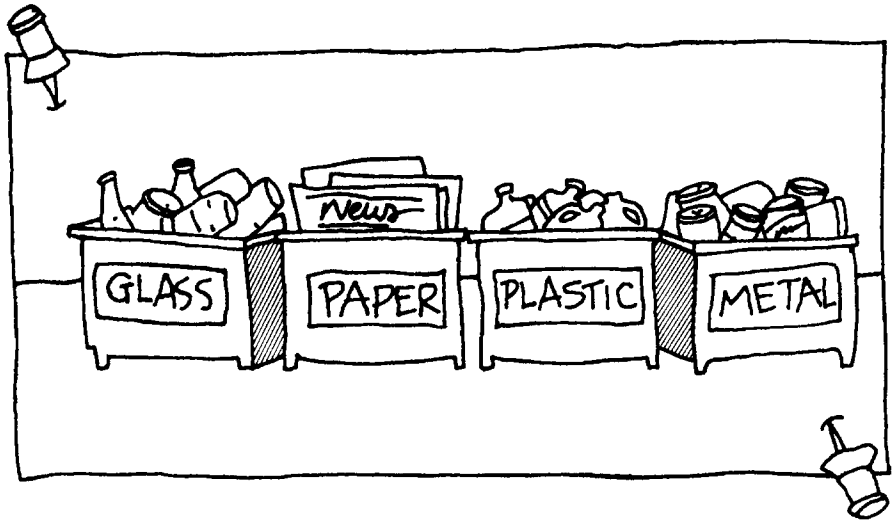
Solutions to the solid waste disposal problem are both interrelated and complex. The MOBIUS Curriculum emphasizes recycling because of its many immediate, positive effects. Recycling reduces the waste stream, and slows the use of virgin raw materials. Recycling is one part of the solution in which every member of society can participate. Children have been effective leaders in the recycling movement as it has gained momentum over the past several years. Armed with the lessons found in this curriculum, children can take part in the solution and learn more about the scientific, historic, economic, and civic aspects of the solid waste disposal problem.

Most important, recycling is a four-step process: separate, collect, process, and market the processed materials to manufacturers who will use them to make new products. Without one step, the cycle is broken. Where do individuals and families fit in?

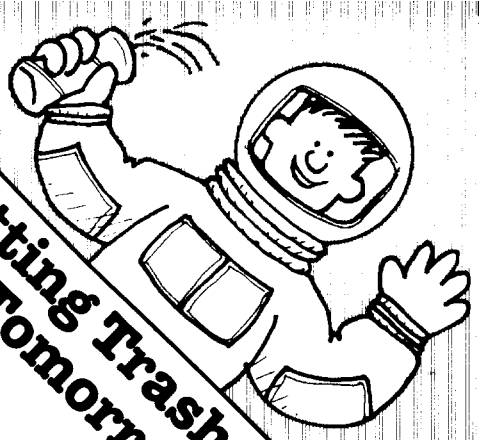
They can actively participate by collecting and separating recyclable items and participating in community recycling programs. Some communities offer neighborhood curbside recycling, while others have central collection or recycling centers where recyclables may be dropped off. To find out where collection or recycling centers are located in your community, look in the yellow pages of your telephone directory under "recycling," call your municipal or county solid waste department, or your local solid waste service company for information.

Note to teachers:

Before you begin your unit of study, you may wish to use the cartoon story, "A Conversation with Mobius," in the packet in the back of this notebook, to help your students gain a better understanding of who Mobius is and what the character represents.



Chapter One



Fitting Trash into Tomorrow

Summary

Applicable to the core subjects science, mathematics, social studies and language arts

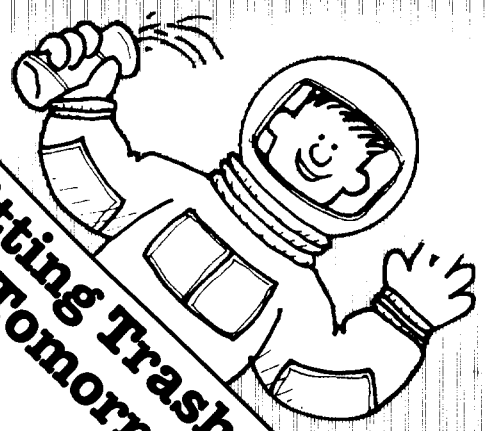
The landfill and composting activities included in this chapter have also been effectively used for Science Fair projects. Included are:

- a pre-quiz to test students' current level of knowledge
- information on the advantages and disadvantages of the major methods of waste disposal: waste-to-energy, sanitary landfills, composting and recycling
- activities that help students see their lessons "come to life," including building a miniature landfill and creating a compost pile
- simple diagrams that help make the lessons easy to understand.

Chapter Objectives

During class discussion, students will be asked to demonstrate their knowledge of **recycling** and the **environmental cycle**. In this lesson, students will also learn about **landfills**, **waste-to-energy plants**, **composting**, and the role each plays in managing **solid waste**. Students will be encouraged to discuss these methods of managing the waste stream and explore the ways in which people, as individuals, can have a positive impact.

Chapter One



Fitting Trash into Tomorrow

Chapter Outline

I. Introducing students to MOBIUS (a cartoon found in the worksheet packet at the end of the notebook)

II. **Lesson One:** Pre-quiz - How Much Do You Know About Solid Waste and Recycling?
   A. Procedure
   B. Student Questionnaire
   C. Class Discussion Using Questionnaire Answer Sheet

III. **Lesson Two:** Where Does Our Trash Go?
   A. Procedure
   B. Sanitary Landfills: teacher background
   C. Waste-to-Energy Plants/Incineration: teacher background
   D. Composting: teacher background
   E. Class Discussion Questions

IV. **Lesson Three:** Recycling Is Not the End, It's Only the Beginning
   A. Procedure
   B. Recycling: teacher background
   C. Class Discussion

V. **Activities**
   A. Make a Simulated Landfill
   B. Feeding Your Garden

Chapter One
Lesson One

How Much Do You Know About Solid Waste and Recycling?

Concepts and Skills Addressed

Vocabulary
Interpersonal Communication
Class Discussion

Materials Needed

Pen or Pencil

Materials Supplied

Pre-quiz questions
Teacher answer sheet

Students will show their knowledge of the waste system and recycling by taking a pre-quiz and discussing the results in class.

A. Procedure

Administer the quiz to students individually or in groups. The quiz can be set up in two ways:

1. If given to students individually, you may elect to give them a block of time to answer all 20 questions and then discuss each answer.
2. If working in groups, you may allow one to two minutes for students to discuss and complete each answer and then discuss the correct answer as a class.

(NOTE: This quiz can also be given at the end of your recycling unit. See Post-Quiz section.)

Can you answer these questions? You may know more than you think!

1. How much **trash** does each person in the United States generate or create daily?

   ___ 1 pound (.45 kilograms)

   ___ 1.5 pounds (.68 kilograms)

   ___ 4.4 pounds (2 kilograms)

   ___ 10.12 pounds (4.6 kilograms)

2. What type of trash do we generate or create more often than any other?

   ___ paper

   ___ glass

   ___ plastic

   ___ aluminum and tin cans

3. If I could change something about the way I recycle, I would

   _____

   _____

   _____

4. Many communities have passed laws that encourage recycling.

   ___ True

   ___ False

5. When I recycle at home, I hope to do a better job at

   _____

   _____

   _____

6. Approximately how many **aluminum** cans are thrown away each year rather than recycled?

___ 100,000

___ 34 million

___ 1 billion

___ 30 billion

7. When I think of all the things that can be recycled and are not, I

_____

_____

_____

8. If I see someone throw a recyclable item away, I

_____

_____

_____

9. How much of our discarded trash is packaging (boxes, bags, wrappers)?

___ too little to measure

___ 10 percent of our trash by weight

___ 29.4 percent of our trash by weight

___ almost all of our trash

10. To **recycle** means to process waste materials into new products.

___ True

___ False

11. To **reuse** means to use something again for the same purpose or to find new uses for it in its original form.

___ True

___ False

12. I like recycling because

_____

_____

13. Most of our **garbage** is:

___ Buried (in landfills)

___ Burned (in waste-to-energy plants)

___ Reused

___ Recycled

14. **Open dumps** are the same as **sanitary landfills**.

___ True

___ False

15. Sanitary landfills protect **ground water** by using liners to contain garbage deposited in them.

___ True

___ False

16. **Waste-to-energy** means trash is burned to create energy.

___ True

___ False

17. The best thing about recycling is

_____

_____

_____

18. Sometimes recycling is hard because

_____

_____

_____

19. As I grow older, I hope recycling

_____

_____

_____

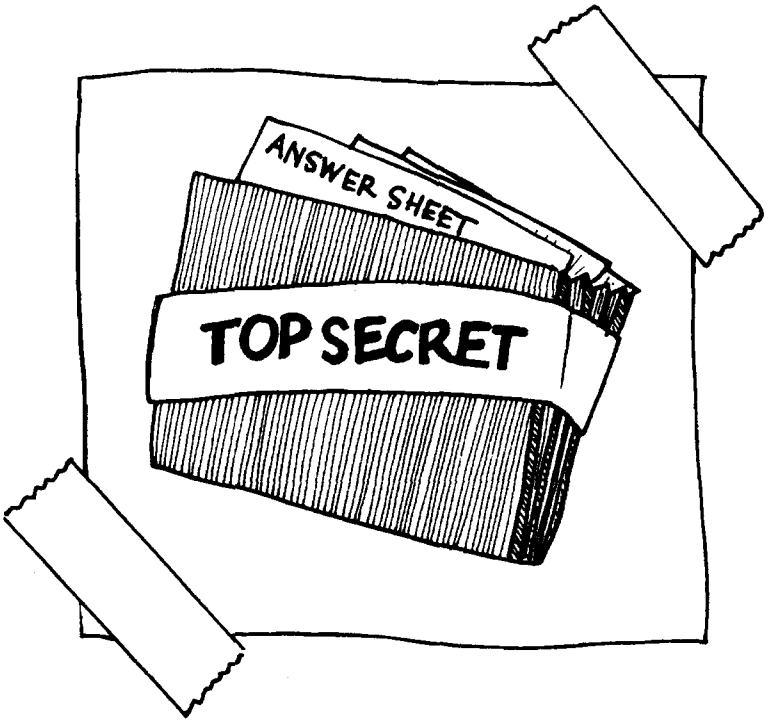
20. To me, recycling means

_____

_____

_____

Teacher Answer Sheet



1. **About 4.4 pounds (2 kilograms).** According to the latest statistics, every American generates or creates about 4.4 pounds of trash a day. If you take an average of 4.4 pounds of trash per American, per day, how much trash would an average American family of four generate in a week? (4.4 x 4 = 17.6 pounds per day; 17.6 x 7 days a week =123.2 pounds a week.) What does 123 pounds (56 kilograms) of trash look like? How much of it could be reused or recycled?

   NOTE: For the first time, the United States Environmental Protection Agency projects a decrease of per capita generation - to 4.3 pounds by the year 2000. Various source reduction activities are expected to have a positive influence in reducing the waste stream. Increased composting efforts and leaving grass clippings on lawns have resulted in less yard trimmings entering the waste stream. Other factors include the effort to reduce packaging and increased government regulations that lead to these actions for more than half of the U.S. population. If we all increase our efforts to reduce, reuse and recycle, we can decrease the amount of trash we generate even more.

2. **37.6 percent of our garbage is paper**. Yard waste (leaves, grass clippings) makes up 15.9 percent; food waste, 6.7 percent; glass, 6.6 percent; metal, 8.3 percent; plastic, 9.3 percent; the remaining 15.6 percent is a combination of other materials like textiles, rubber, wood, and rubble.

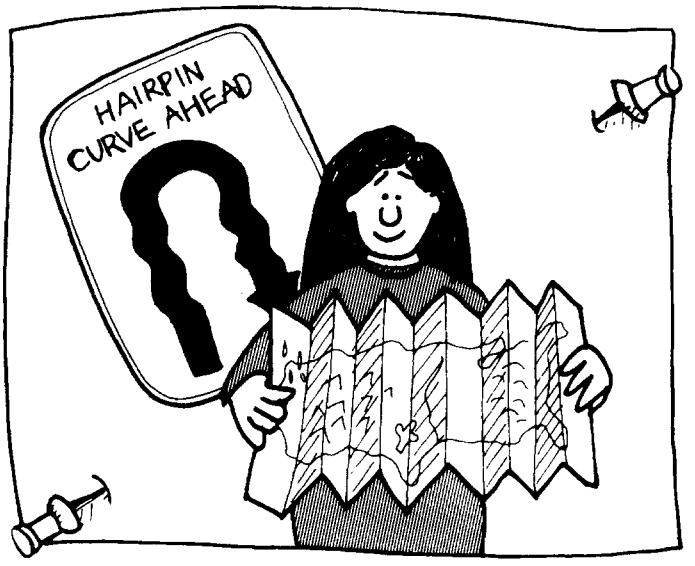
3. Ask students to read their answers and discuss.

4. **True.** By 1995, all states had passed some type of recycling legislation. These laws provide a framework for statewide recycling efforts and, in some cases, require local governments and citizens to participate in collection efforts. There has been a big change since 1989-90. At that time, there were approximately 1,000 curbside recycling programs in operation in communities around the country. By 1995, there were more than 6,500.

5. Ask students to read their answers and discuss.

6. **Approximately 30 billion aluminum cans are thrown away, rather than recycled, each year in the United States.** Other statistics: 2.97 million tons (2.7 million metric tons) of tires are thrown out; 51.4 million tons (46.6 million metric tons) of paper; 10.7 million tons (9.7 million metric tons) of glass; and 18.6 million tons (16.9 million metric tons) of plastic are discarded every year.

7. Ask students to read their answers and discuss.
8. Ask students to read their answers and discuss.
9. **29.4 percent by weight and 32.1 percent by volume of discarded waste is packaging.** This means a large percentage of what we buy is packaging that in most cases is disposed of immediately.
10. **True.** An example of recycling is turning newspaper into egg cartons. Recycled glass bottles and jars are melted down to make brand new bottles and jars. Recycling is different from reusing.
11. **True.** To reuse means to use something again for the same or a different purpose than the item's original form. For example, when we return our empty bottles to the store and they are cleaned and used again, or when we use the back of a sheet of paper for notes or to find the answer to math problems, instead of using a new sheet.
12. Ask students to read their answers and discuss.
13. **62.4 percent of our garbage is buried in landfills** (a reduction of about 10 percent from 1989); approximately 15 percent is burned in waste-to-energy plants to produce energy, 18.6 percent recycled, and 3 percent composted.
14. **False.** Open dumps contain waste that is allowed to remain exposed to the atmosphere over long periods of time. Open dumps are being phased out in the United States. Sanitary landfills are different. They contain a specially designed liner that protects the environment by keeping the waste sealed within the ground. Heavy machinery covers the waste daily with six inches of soil or a special fabric cover. Today there are between 5,000 and 6,000 sanitary landfills in the United States that can accept household trash. However, developing new landfills is difficult because land that is suitable is hard to find near cities and towns where a majority of our waste is created. More and more waste is being generated, but fewer and fewer places are being found to put it all.
15. **True.** The liners used in sanitary landfills protect ground water by preventing leachate (see glossary) from seeping into the water supply.
16. **True.** Waste-to-energy plants reduce waste volume by converting waste into heat energy and a small amount of ash. Waste-to-energy is a reliable source of waste disposal.
17. Ask students to read their answers and discuss.
18. Ask students to read their answers and discuss.
19. Ask students to read their answers and discuss.
20. Ask students to read their answers and discuss.



Chapter One
Lesson Two

Where Does Our Trash Go?

Concepts and Skills Addressed

- Vocabulary
- Interpersonal Communication
- Class Discussion

Materials Needed

None

Materials Supplied

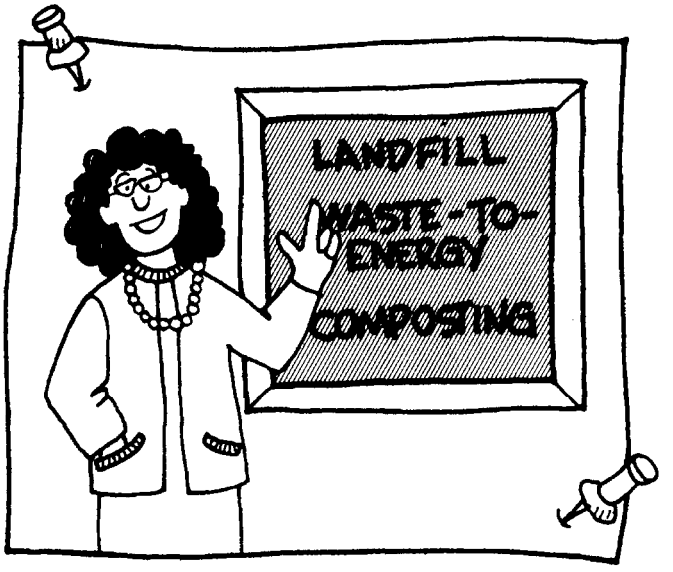
Teacher background information on landfills, waste-to-energy plants/ incineration, and composting. Diagrams of a landfill site, a waste-to-energy plant, and the food web of a compost pile suitable for copying or overheads.

Students will learn the benefits and limitations of three of the four methods of solid waste disposal: sanitary landfills, waste-to-energy plants, and composting. (The fourth, recycling, is discussed at length in subsequent lessons and chapters.) They will learn:

The five points about landfills:

a. They are the most common form of waste disposal.
b. They are constructed on carefully chosen sites and lined to protect the environment, which is why they are called 'sanitary'. Waste deposited in landfills is covered daily with soil or a special fabric cover.
c. They are different from dumps, which are being phased out in the United States.

d. They are filled by trucks hauling garbage to the site, where it is spread out, then crushed and compacted with heavy equipment and covered daily with soil or a special fabric cover. Rainwater and liquids from the decomposing waste combine to create **leachate,** which collects at the bottom of the landfill. Leachate is pumped out and treated in a leachate or **sewage** treatment facility.



e. They create gases as the organic material **decomposes**. Half of this gas is **methane**, which is **combustible** and can be used as fuel. The rest of the gas is **carbon dioxide**; it, too, can be recovered and used for industrial purposes.

The four points about waste-to-energy:

a. It is the modern, safe method of burning waste while producing a useful by-product.
b. The burning garbage creates heat to make steam that drives machinery capable of producing electricity.
c. It reduces the volume of waste by as much as 90 percent.
d. It does not eliminate the need for landfills to dispose of the ash or other non-combustibles.

The three points about composting:

a. It makes use of organic materials such as yard waste, food scraps, and other plant and soil materials.
b. It decomposes to create a useful, enriching soil additive called **humus**.
c. It saves space in landfills by recycling organic material.

A. Procedure

1. Read the background information on landfills, waste-to-energy/incineration, and composting.
2. Use the diagrams to help explain the main points mentioned above.
3. There may be examples of each of these disposal methods in your area or your school yard. Consider a field trip to a nearby landfill or waste-to-energy plant. Walk through the school yard to see how leaves and other organic materials are decomposing right under our feet.
4. Check the students' knowledge by clarifying the five points about landfills, the four points about waste-to-energy, and the three points about composting.

B. Background on Landfills

Today a majority of North America's waste is buried in sanitary landfills. The United States and Canada are phasing out "open" dumps because they are harmful to the environment. Dumps allow leachate to enter the ground water; attract rodents, insects, and other disease-carrying vermin; emit odors; and create a fire hazard. Sanitary landfills contain a specially designed liner, or multiple liners, buried deep in the ground under the entire site. This liner - protects the environment around the landfill. To guard against critters, odors, and litter, heavy machinery compacts the incoming waste, which is then covered daily with soil or a special fabric cover.

If carefully constructed in a suitable geological location, sanitary landfills are **environmentally sound**, which is why they are called sanitary. Here's how landfilling works:

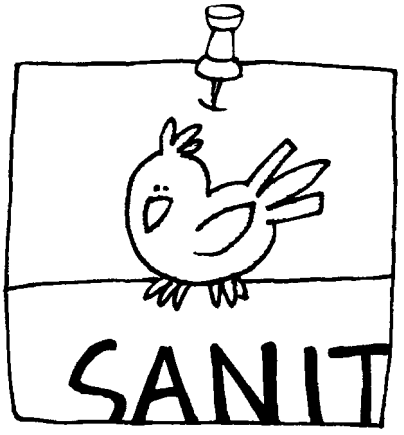
Garbage is hauled from households and industries to the landfill site. A fee is paid to the landfill operator based on how much trash the truck carries. This fee is called a **tipping fee** because the trucks lift their loads to 'tip' them on the face of the landfill.

Waste materials are unloaded, spread out, and compacted by bulldozers and landfill compactors. At the end of each day, the waste is covered with soil or a special fabric cover. Until recently, it was believed that all waste decomposed completely in landfills. However, recent studies by Professor William Rathje of the Department of Anthropology at the University of Arizona have proved this to be wrong. In his examination of waste buried for 15 years or more, he has found legible newspapers and even chicken bones with meat still on them.

At an average landfill, waste and soil are alternately layered to a depth of 10 to 30 feet (3 to 9 meters) and rise above the level of the land by 50 to 100 feet (15 to 30 meters) depending on permit requirements.

Several layers of waste comprise a **cell**. A cell is typically one part soil to four parts waste. Cells are built side by side and on top of each other until the landfill is completely filled (See landfill diagram, pg. 28).

1. Preventing Groundwater Contamination



In open dumps, liquid leaking into the soil from waste materials often **contaminates** ground water, lakes, and streams. This may threaten our drinking water.

A sanitary landfill, however, is lined with clay, thick man-made plastics, or both to prevent harmful fluids from leaking into ground water. This liquid, called **leachate**, is a mixture of rain water and other liquids created by the decomposing garbage. Leachate drains into collection pipes at the bottom of the landfill. The leachate can be treated at the landfill or at a sewage treatment plant. Landfill operators sample ground water at the landfill regularly and send it to laboratories for analysis.

As trash decomposes, gases can be created. Decomposition creates methane, carbon dioxide and small amounts of **hydrogen sulfide**. These gases can build up and move around under the ground and eventually escape into the environment. To prevent this from happening, the gas is collected in a controlled manner and safely burned or used as fuel.

2. Completed Cells and Landfills

When a cell is filled, it is closed by covering the layers of dirt and waste with a clay cap and packing it into a solid surface. Soil is then layered over the clay. When a landfill is completely filled, several feet of additional **impermeable** soil is placed over it and grass covering is planted on top. Completed landfills are monitored for ground water, leachate and gas for 30 years after they close. That has been the law in the United States since October 1993.

Landfills remain useful even after they are closed and can be turned into parks or recreation areas. Also, energy recovery plants can be constructed on the landfill site to use the recovered gases.

3. The Advantages of Sanitary Landfills

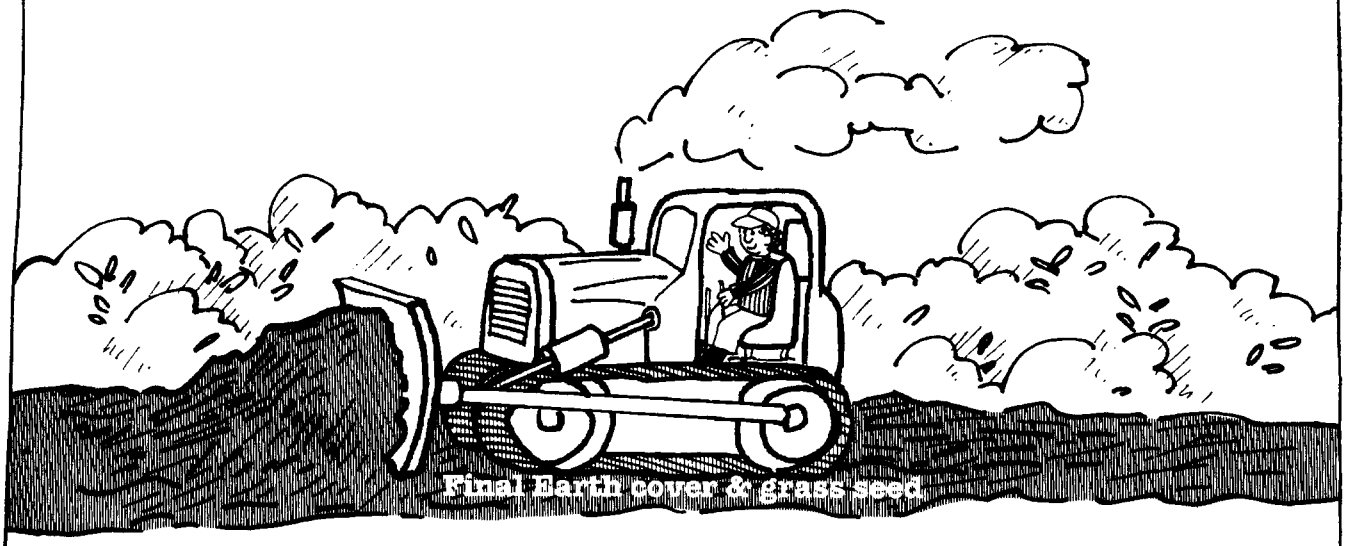
Modern engineering allows landfills to protect ground water, and they are less expensive to construct and maintain than waste-to-energy plants.

- They accept all types of garbage except **hazardous wastes**.
- They are useful as recreational areas after they are full.
- They are necessary to contain residue from every other process of disposal.
- They can be sources of alternative energy (e.g., saving fossil fuels) by using the recovered gases.

4. The Disadvantages of Landfills

- They require specific soil types and geological conditions.
- They must be accessible and close to communities. (These sites are becoming harder to find.)
- They are filling up much faster than originally anticipated.
- If not properly designed or managed, they can cause pollution problems.

Layers of the Landfill



Clay cap

Compacted solid waste

Daily cover

Compacted solid waste

Daily cover

Compacted solid waste

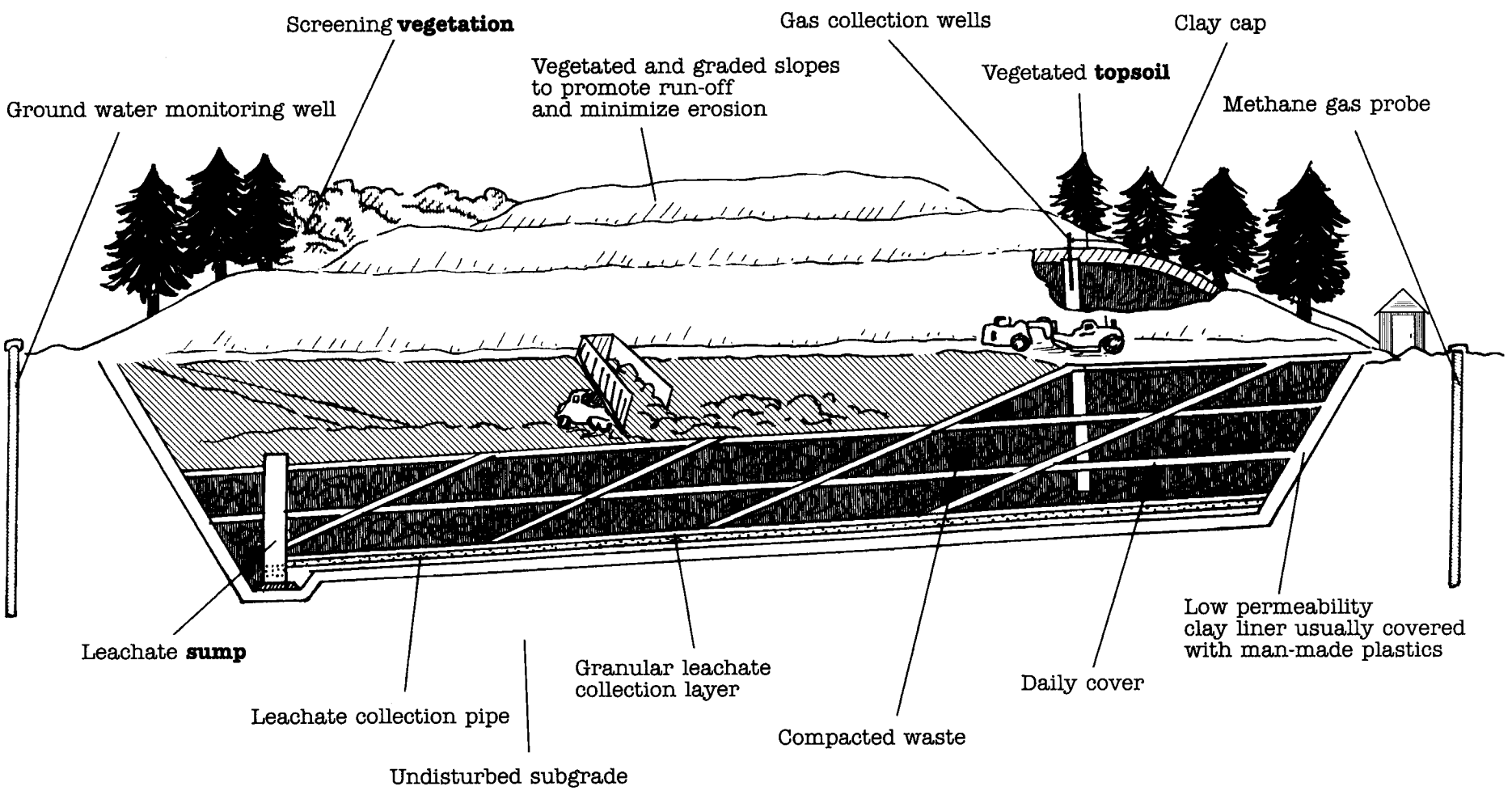
Daily cover

Compacted solid waste

Protective liner

Compacted clay

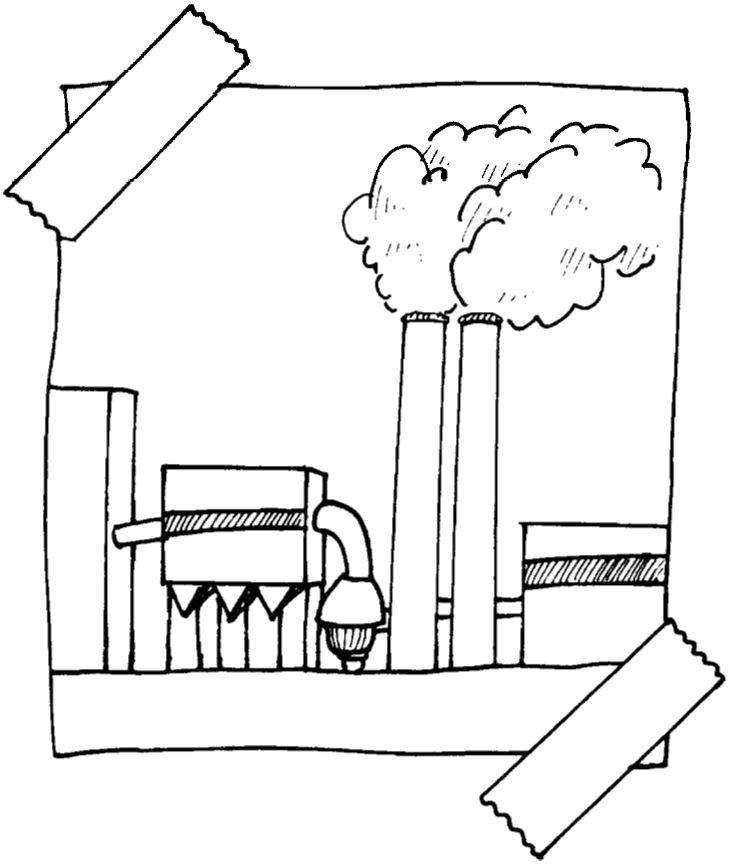
Landfill Diagram



C. Background on Waste-to-Energy / Incineration

To **incinerate** means to burn to ashes. When garbage is incinerated, it is burned in large furnaces, and the remaining ashes take up less space in our landfills.

The modern, safe and responsible way to burn waste, while also creating a useful resource, is in a waste-to-energy plant. The burning waste creates heat, which is used to produce steam. The steam can then generate electricity for homes and businesses. These facilities, in addition to saving landfill space, also protect ground water and drinking water. The process takes place inside a building, which traps odors.



Waste-to-energy facilities must successfully manage both air quality and ash disposal. Ash from the facility must be tested and disposed of in a landfill. Sometimes special landfills are made just for ash disposal. They are called **ashfills** or **monofills**. Gases may be emitted by the waste-to-energy plant, but can be controlled through complex filter systems and careful monitoring.

1. The Advantages of Waste-to-Energy

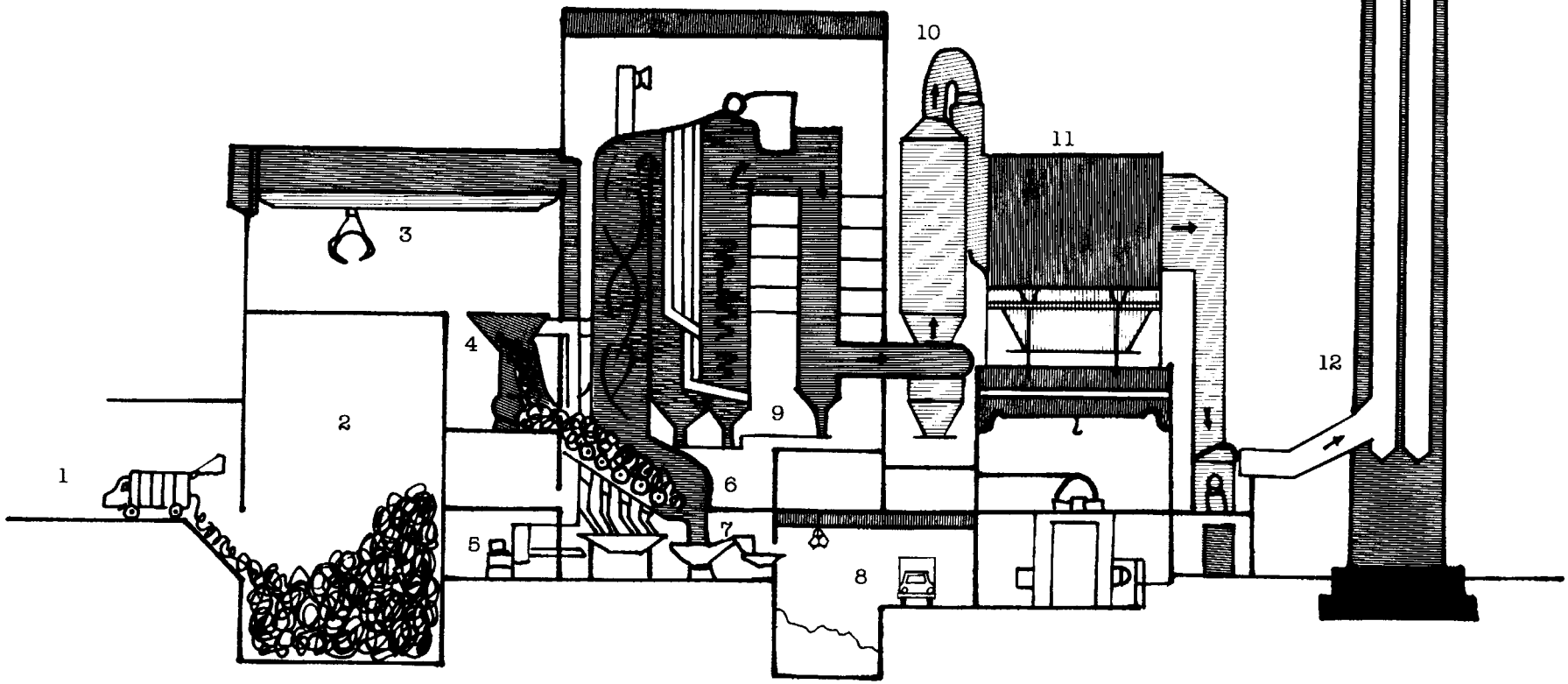
- It is an alternative energy source.
- It can reduce the volume of waste by approximately 90 percent.
- It traps odors inside.

2. The Disadvantages of Waste-to-Energy and Incineration

- In order to eliminate gases emitted into the atmosphere, special devices are required that are costly to build and must be carefully monitored and maintained.
- Landfills are needed to dispose of the ash.
- Not all materials are combustible, which makes other waste disposal alternatives necessary.

How Waste-to Energy Facilities Work

1. The tipping hall where trucks go
2. Refuse bunker where trucks put garbage
3. Refuse crane
4. Charging hopper that sends waste to grate
5. Under-fire fan
6. Roller grate for burning refuse
7. Ash conveyers
8. Ash bunker and crane for collection and transport
9. Fly ash collection: first stage of air cleaning
10. Scrubber to remove acid gases
11. Dust collector
12. Stack: final stage of air cleaning

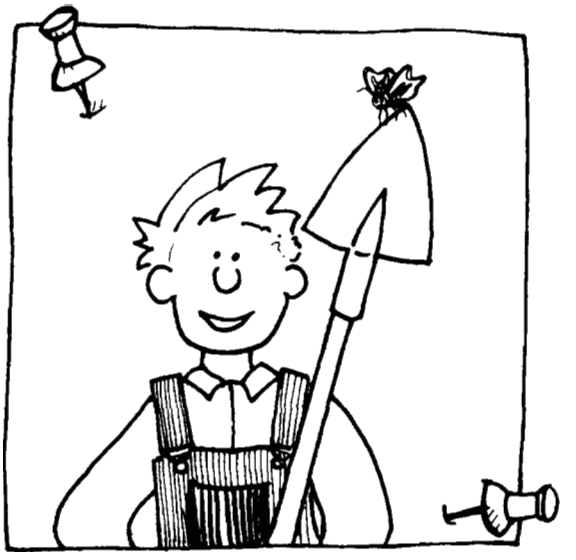


D. Background on Composting

Composting is a process that creates an enriching soil additive, called humus, from organic materials gathered together and left to decompose.

Yard waste, food scraps, and other organic plant and soil materials can be put into a compost pile to decompose. However, some city and apartment dwellers do not have yard space available.

Many backyard compost piles are made of chicken wire to form a pen for the yard waste. This structure exposes much of the waste to the elements. Air and waste mix with the compost, and **bacteria** and other **microorganisms** found in nature generate temperatures as high as 150 degrees Fahrenheit (65 degrees Celsius). This heat cooks the waste and eventually creates humus: a rich, natural fertilizer. Humus is high in carbon, nitrogen and other nutrients, which are important sources of food for lawns, gardens, fields, trees, plants, and vegetables. Compost bins can also be purchased from many hardware and department stores.



Composting can also be done community-wide. Some waste services companies pick up yard waste and other organic material separately and take it to a compost area. Here, the decomposing waste is managed by turning the piles to expose as much of the waste as possible to the air and **precipitation**.

1. The Advantages of Composting

- Compost material enriches the soil and plants.
- Composting can be done safely in your backyard and maintained by periodically using the humus.
- Composting saves space in landfills by reusing organic materials.

2. The Disadvantages of Composting

- Some organic materials take a long time to decompose, and some city and apartment dwellers do not have yard space available.
- Composting is limited to organic material only.
- Humus must be used as a fertilizer to be most effective, and organic materials should be added to the compost pile regularly to maintain a ready supply.

Food web of the compost pile

1° = First level consumers
2° = Second level consumers
3° = Third level consumers

In the food web of the compost pile, just as in a spider web, each piece is connected and needs the other for support. It is very important to remember that if one piece is missing, none of the consumers can survive.

How does the compost pile work? Organic residues such as vegetables, fruits, breads, egg shells, coffee grounds and tea bags start to decay with the help of the first-level consumers, molds, bacteria and actinomycetes. Then along comes the second-level consumer, the earthworm. He eats mold, bacteria and actinomycetes. Next comes the third-level consumer, the centipede or ground beetle who eats the earthworm and so on. This is how the food web works. Each level of consumers survives by eating the organisms in the level below it. Remember, if one piece of this web is missing, none of the consumers can survive.

Discussion Questions on Sanitary Landfills

- How does a sanitary landfill differ from an open dump? How are sanitary landfills designed to protect the environment?
- Why is it important to protect the ground around and under a sanitary landfill?
- What does it mean to use an integrated solid waste system and how do landfills fit in?
- What is one of the advantages of sanitary landfills?

Discussion Questions on Waste-to-Energy

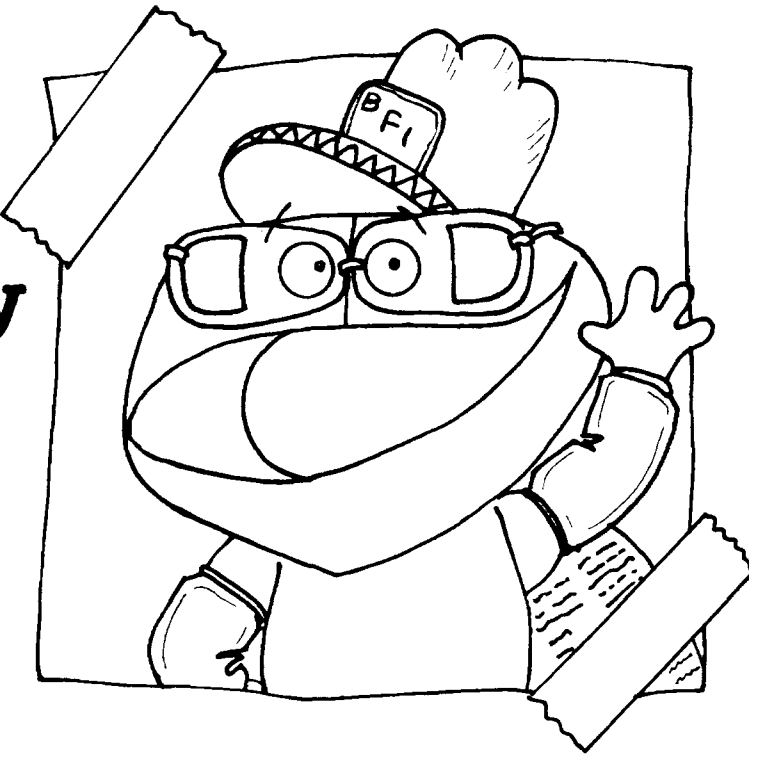
- What advantages does this method of processing trash have over other ways to dispose of garbage (like putting it in landfills, composting, or recycling)?
- How does waste-to-energy fit into an integrated solid waste system?
- What concerns should we have in using waste-to-energy to dispose of trash?

Discussion Questions on Composting

- What kinds of materials decompose in a compost pile? What will not?
- What is the rich material created by composting? How can it be used?
- What do you need to make a compost pile? How should you take care of it?

Chapter One
Lesson Three

Recycling Is Not The End, It's Only The Beginning



Concepts and Skills Addressed

Social Science
The Environmental Cycle
Arithmetic

Materials Needed

Trash bag filled with recyclable and nonrecyclable items weighing about 4.4 pounds (2 kilograms)

Materials Supplied

Glossary of terms
"Recycle Cycle" cartoon (found in the worksheet packet)

Students will learn how waste is generated, where waste goes, and how to reduce it through recycling.

A. Procedure

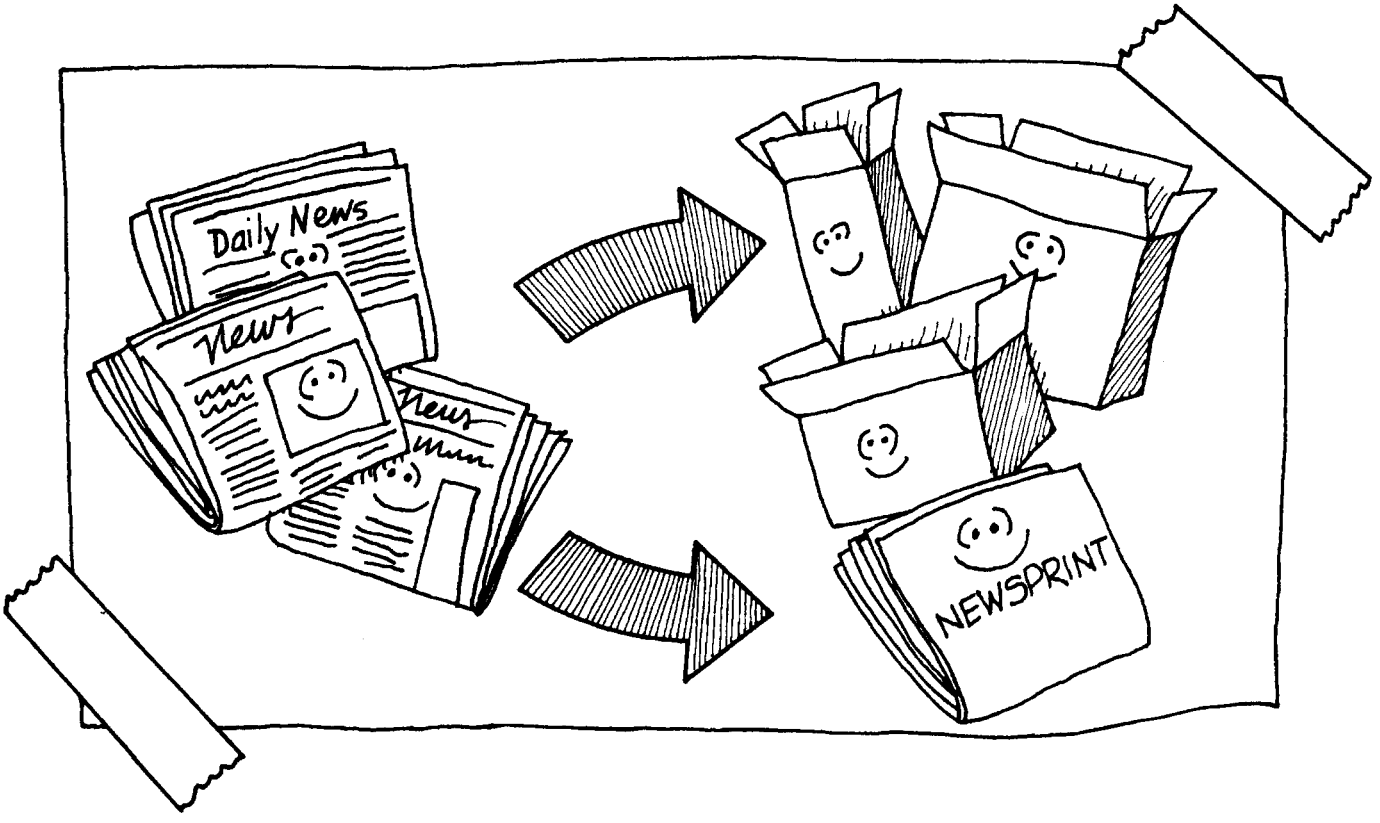
1. Read the background information on recycling.
2. If your class has not yet seen the two cartoons provided in the worksheet packet at the back of the notebook (one introduces MOBIUS, the other explains the "Recycle Cycle"), show them now. Refer to the Recycle Cycle as an example of the environmental cycle mentioned in the discussion questions for this lesson.
3. Refer to the pre-quiz taken earlier and explain that the class is going to discuss some of the issues involved with recycling. Make it clear that usually there are many possible answers to your questions.

4. You may want to gather some visual aids to help your discussion: paper, a beverage can, a glass jar, a plastic milk jug, etc. You can involve students by handing these items out and asking students to show them when the time comes.

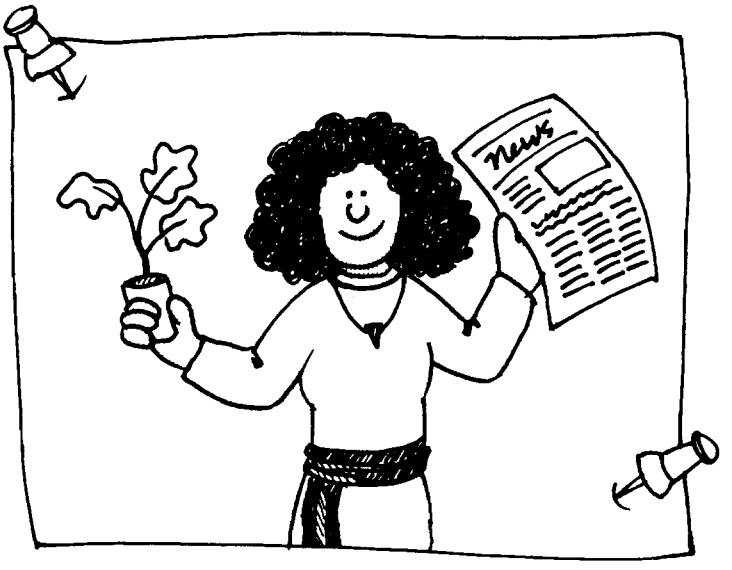
B. Background on Recycling

To recycle means to separate waste resources and process them to make new products from the same materials. For example, newspapers can be recycled into fresh newsprint or cardboard boxes, and beverage cans can be made into new beverage cans. Many products that can be recycled feature the recycling symbol on the container.

We advise a class discussion to explain the process and advantages of recycling and its role in controlling the solid waste overflow. During this discussion, many teachers have found it helpful to include a "trash bag" demonstration (see "A. Procedure," #4) to give students an opportunity for a practical "hands-on" learning experience. As you discuss the various items in the trash bag, students can decide which ones are or are not recyclable and can familiarize themselves with the recycling symbol found on many recyclable products. With the background provided on landfills, composting, and waste-to-energy, we have shown where trash goes when it leaves our homes. Recycling is best described by looking first at where trash comes from.



C. Class Discussion



What is an 'environmental cycle'?

Answer: An environmental cycle is a continuous chain of natural events that happens all around us every day. For example, a new tree sprouts from the ground in your back yard. Over the years, its roots draw water and minerals from the soil and make food using sunlight. This process is called **photosynthesis**. While it grows, the tree's leaves help purify the air we breathe. Each year it drops seeds to the ground that sprout into seedlings. When it is old, the tree dies, falls down, and **decays**. Nutrients from its wood enrich the soil so the saplings can grow into healthy new trees. Over the years, the young trees that grew from your tree's seeds become mature trees, and the cycle begins all over again.

What does the environmental cycle have to do with recycling?

Answer: Just as nature has its environmental cycle, when we recycle we create the recycle cycle. Instead of using virgin raw materials that come from nature to make new products, the recycle cycle enables us to use the materials in used products to make new ones. For example, recycled bottles may become jars, drinking glasses or new bottles, recycled aluminum beverage cans may become aluminum foil and so on. By recycling, we are helping to preserve our natural resources and reducing the amount of waste that is discarded.

Where does paper come from?

Answer: Paper is made from **wood pulp**, which is manufactured when trees are cut down and ground into small pieces. Mixed with starch and water, the pulp forms a paste, which is squeezed through rollers to make paper. Most paper is recyclable. It doesn't have to be thrown away after it's been used. It can be broken down and made into new paper products.

What is glass made of ?

Answer: Glass is actually sand - tiny rocks that are cleansed of impurities and then heated. The rocks melt into a liquid that turns into glass when cooled. Glass is also recyclable. Glass bottles and jars are recycled by being crushed into **cullet** and melted down to make new glass containers. Cullet is also used to make **fiberglass** and is mixed with **asphalt** to make **"glassphalt,"** a paving material.

What is used to make beverage cans?

Answer: Most beverage cans are made of aluminum. Lightweight and flexible, aluminum is perfect for products like beverage cans. It is also a **recyclable** product. Aluminum foil and trays, along with beverage cans, can be melted down and made into new cans, foil, or trays many times before they have to be thrown away for good. Like paper and glass, they can't be recycled forever. Just as your pants wear out at the knees or your sneakers get holes in the bottoms, recyclable products wear out, too. But they can last much longer than they do today. Usually, some new aluminum is added during remanufacture to preserve the strength and lengthen the life of the product.

Each of these materials - glass, paper, and aluminum - comes from raw materials found in nature. They are made into products we use every day, such as cereal boxes, beverage cans, and cookie jars. When we use these products and are finished with them, we usually throw them into the trash. But nature can't supply the resources to make beverage cans and pickle jars forever.

What about plastic? Is it recyclable?

Answer: Yes, but only about 4 percent of plastic is recycled each year. However, this is expected to increase as recycling technology improves and more and more uses for "post-consumer" **resins** are found. Industry specialists predict that 50 percent of plastic soft drink bottles may be recycled by the year 2000.

When the trash truck comes and takes away our trash, where does it go?

Answer: When people participate in a neighborhood curbside recycling program, items such as glass jars, newspaper, aluminum beverage cans, metal cans, plastic milk jugs, and soft drink bottles are picked up and taken to a recycling center. When there is no curbside recycling program, people can collect their recyclables and take them to a collection or recycling center. There, the materials are sorted by **grade**, baled, crushed, or otherwise processed for transport, and sold to companies that will make new products out of them.

Materials such as paper and plastic are manufactured in different grades. Newsprint, for instance, is a different grade of paper than computer print-out paper. Each grade is recycled separately. Some communities and waste disposal companies burn part of the trash in waste-to-energy plants. The burning trash produces steam which can be used to make electricity. Most often, trash is taken to a landfill where it is covered with dirt.

What is a landfill?

Answer: A landfill is an engineered method for disposing of waste on land. (For more information see glossary and Chapter One, Lesson Two.)

How do we protect the environment at the landfill?

Answer: Modern landfills are dug out and coated with one or more thick liners before the solid waste is deposited. This liner helps protect the environment, especially the ground water. After the waste is deposited, it is covered with earth, or a special fabric cover, which also protects the environment. There are also special measures taken to collect leachate and gases from decomposing garbage.

What would happen if there were no place to put all the solid waste?

Answer: We would see trash everywhere and our homes and communities would become very unhealthy because of improperly discarded waste.

We've talked about recycling and landfills. In what other ways can we dispose of solid waste?

Answer: Waste-to-energy and composting.
(These processes are described in detail earlier in Chapter One.)

What does "waste-to-energy" mean and how does it work?

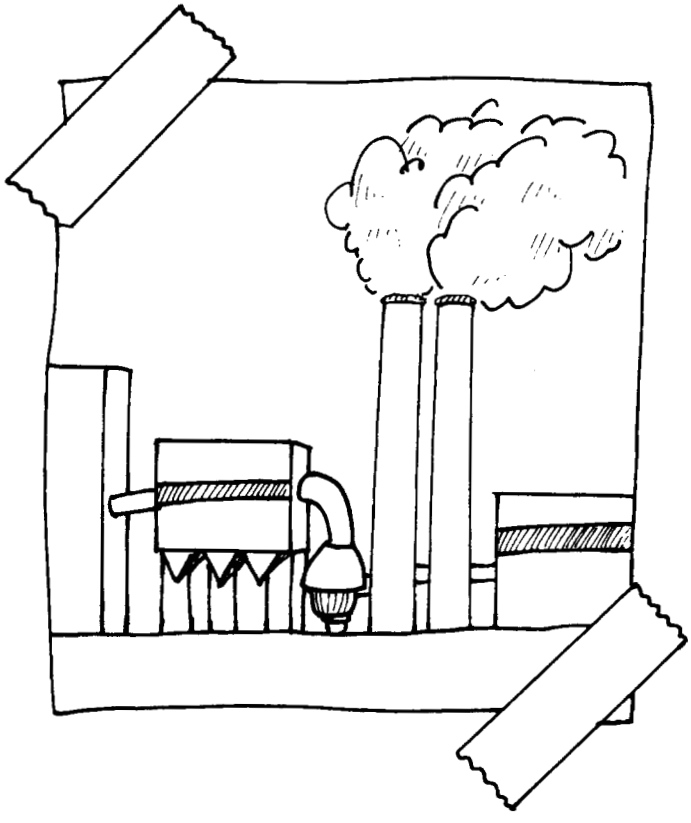
Answer: Waste-to-energy is the method of waste disposal that burns garbage to produce energy. Garbage is placed in a huge furnace, or fireplace, and burned until nothing is left but ashes. The heat given off by the burning waste can generate electricity for lights, electric toys, television, heat, and so on.

What does 'composting' mean and how does it work?

Answer: Composting is the management of a natural process in which organic materials, such as grass clippings, food scraps, tree branches, and leaves, are gathered together in a big pile and left to decompose into a rich soil additive called humus.

Long ago, before heavy trucks and big machines, what did people do with their garbage? What kind of garbage did they have?

Answer: We'll talk about this when we look at "Fitting Trash into Yesterday."



Science Activity

Make a Simulated Landfill

Objective

Students will observe that some materials decompose in a landfill, while others do not. They will learn the difference between organic and inorganic materials and understand how a landfill works.

Vocabulary

Landfill
Decompose
Organic
Inorganic

Time Needed for Activity

20 days (4 school weeks) or longer

Materials Supplied

Worksheet for recording observations

Materials Needed

A shoe box or aquarium to serve as the landfill site. Foil or plastic to serve as a waterproof liner (litter-box liners are ideal); soil (NOT POTTING SOIL - it doesn't have the necessary microorganisms); toothpicks and labels, which will indicate the location and contents of the buried garbage; water; a drinking straw, which will signify the leachate collection system; coffee stirrers to signify the methane gas recovery system; a magnifying glass or microscope and slides; a selection of organic and inorganic materials to be buried in the landfill (e.g., orange peel, apple core, newspaper, glossy magazine paper, cardboard, glass, cotton cloth, aluminum foil, etc.).

Procedure

1. Describe a landfill to students, noting that landfills not only hold waste but also allow some materials to decompose.
2. Explain that the landfill (shoe box or aquarium) has already been sited in an environmentally sound location and lined with 10 feet of compacted clay.
3. Line the box with plastic, which represents the landfill liner.
4. Place a drinking straw on the liner to signify the leachate collection system.
5. Cover with 4 inches of dirt and compact.
6. Have students look at the garbage under a magnifying glass or microscope and predict which materials will decompose and which will not decompose by writing a hypothesis in the space provided on the worksheet.
7. Empty your load of garbage into the landfill and spread it out so that you can mark each piece. (When trucks unload at actual landfills, it is called "tipping.")
8. Write the name of each item of garbage on a separate label and attach each label to a toothpick, like a flag.
9. Mark the location of each piece of garbage with the appropriate "flag."
10. Cover each item of garbage with about two inches of dirt and compact the dirt.
11. Insert two coffee stirrers into the dirt to signify your methane gas recovery system.
12. Have students date their worksheets and note the objects they buried.
13. Keep the simulated landfill in a sunny place and lightly water as needed to keep the soil moist. (Usually once a week for two school weeks.)
14. After 10 days (2 school weeks), dig up garbage and have students examine it with the microscope or magnifying glass. Ask students to record their observations on their landfill worksheet.
15. Return all items to the landfill, bury and compact. Repeat the same procedure in 10 days (2 school weeks) and have students record their findings.
16. When it is time to "close" the landfill, remove the toothpicks and add an additional 4 inches of soil to the landfill and compact. This represents the final cover.
17. Plant grass seed in the dirt on top of the landfill.

Note to teachers:

To assure the health and safety of your students, all students should be required to wear protective gloves when working on the miniature landfill. The gloves should be made of an impermeable material, such as rubber or plastic. Many school districts have established policies regulating the health and safety of students in various age groups. Check with the appropriate department in your school district if you feel you need additional information.

Name _____ **Date** _____

Simulated Landfill
Worksheet

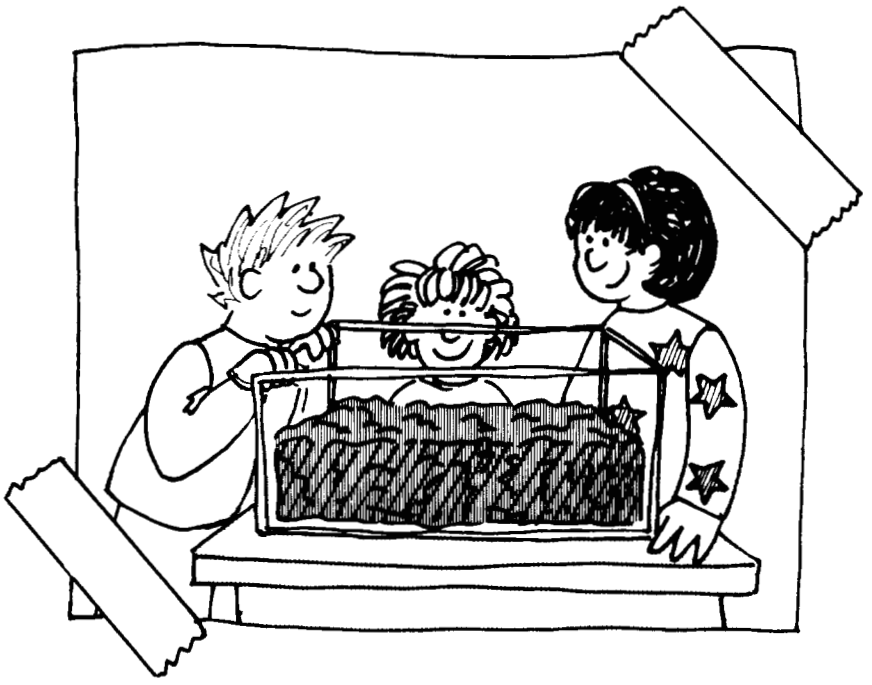
Hypothesis:

	Observations	
	After 10 days	**After 20 days**
Objects:		
1.		
2.		
3.		
4.		
5.		
6.		

Conclusion:

Science Activity

Feeding Your Garden



Objective

Students will observe and record the results of decomposition in a contained compost pile. While students won't be able to see the microscopic activity at work in the process of decomposition, teachers can enhance students' understanding by explaining the "unseen" world.

Yard waste decomposes when exposed to air, water, bacteria, and other microorganisms. Students will observe that the temperature of the composting mixture rises. Bacteria and microorganisms generate temperatures as high as 150 degrees Fahrenheit (65 degrees Celsius), thereby "cooking" the yard waste.

Finally, students should learn that composting creates a natural fertilizer rich in carbon, nitrogen and other nutrients called humus. This fertilizer provides nourishment for growing plants.

Vocabulary:

Yard waste
Decomposition
Bacteria
Microorganism
Humus

Time Needed for Activity:

Three weeks or longer

Materials Supplied:

Sample worksheet for recording observations

Materials Needed

A 10-gallon aquarium or similar container; yard wastes (grass clippings, food waste, leaves) enough to fill the container 1/2 to 2/3 full; a large spoon or yardstick to stir the mixture; a ruler or yardstick to measure the height within the container; a thermometer to measure the temperature of the mixture; a handful or two of soil (not potting soil).

Procedure

1. Tell students that they are going to observe how nature returns leaves, grass, and other plant and animal life to the soil through the process of decomposition.
2. Have students spread out the grass clippings, leaves, soil, etc., in the aquarium and add just enough water to make it moist. Do not compact the material; make sure there is sufficient air to help the decomposition process. From time to time, use the "squeeze test" to find out if more water is needed. (Pick up a clump of the compost pile. When you can just barely squeeze a drop or two of water out of it, add water.)
3. At the start of the activity, ask each student to write a hypothesis about the outcome of the activity in the space provided on the worksheet.
4. Record any initial observations on the worksheet: color, smell, height, temperature. This may be done individually or in groups. Record observations periodically for three weeks.
5. After three weeks, discuss your findings at each stage of observation and empty the container in an appropriate location outside.
6. Ask students to write their conclusions on their worksheets, summarizing the changes they observed over the course of the experiment.
7. Have students match their hypotheses to their conclusions. Ask them if they were surprised by the results of composting.

Note to teachers:

To assure the health and safety of your students, all students should be required to wear protective gloves when working on the compost project. The gloves should be made of an impermeable material, such as rubber or plastic. Many school districts have established policies regulating the health and safety of students in various age groups. Check with the appropriate department in your school district if you feel you need additional information.

Name _____ **Date** _____

Feeding Your Garden
Worksheet

Hypothesis:

Day	Date	Temp.	Height	Smell	Appearance and Changes
1					
2					
3					
4					
5					
6					
7					
8					

Conclusion:

Chapter Two

Fitting Trash into Yesterday

Summary

Applicable to the core subjects social studies and language arts

Included are short skits on the history of waste that illustrate:

- how trash is part of the environmental cycle
- how trash was handled in the past
- reasons for our culture's accelerating waste disposal problem.

Chapter Objectives

Students will learn how trash was handled in the past, and how our current methods of disposal have evolved. Through dramatized examples, students will compare nonindustrialized cultures with modern society. Students will see how we've evolved into a culture with an accelerating waste disposal problem.

Chapter Outline

I. **Lesson One:** "Here Today, Still Here Tomorrow"
   A. Procedure
   B. "Here Today, Still Here Tomorrow"
      Part 1: "Before Treasure Existed"
      Part 2: "One Maid's Trash is a Princess' Treasure"
      Part 3: "Treasures Under the Tree House"

II. **Activity**
   A. Mural, Mural on the Wall...

Chapter Two
Lesson One

"Here Today, Still Here Tomorrow"

Concepts and Skills Addressed

History
Interpersonal communication and expression
Theater Arts

Materials Needed

A cleared area for the performance, about 10' x 20'
Some simple props

- "Before Treasure Existed" - a stick for mixing, a trash can for a cook pot, some rulers and yard sticks for bones, a stuffed toy or substitute for a fish, a coat to drape over the old woman's shoulders.
- "One Maid's Trash is a Princess' Treasure" - two chairs to serve as horses, a trash can for the wash bucket, a broom to make the guard look official, a stone to serve as a spearhead, a chair or desk for Brenda to stand on.
- "Treasures Under the Tree House" - a shovel, a cap for Justin, a pillow for Dad's stomach, a stone to serve as a spearhead.

Materials Provided

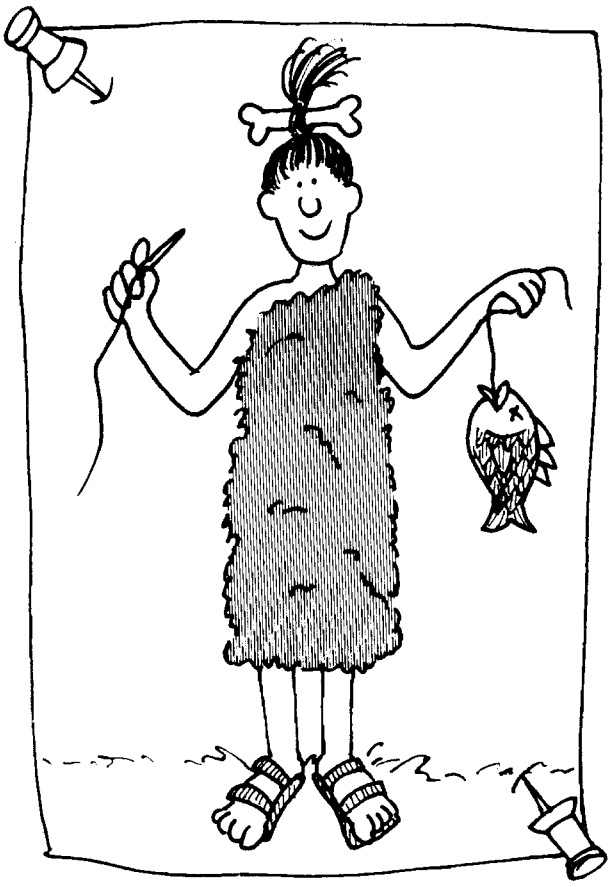
Script for "Here Today, Still Here Tomorrow"

Students will have the opportunity to dramatize the evolution of waste and waste disposal. They will see how waste continues to exist through time. They will also have some fun.

A. Procedure

1. Explain to the students that each short play illustrates something about waste disposal and the environment and to watch for these messages.
2. Choose a narrator to set the scene for each part and cast the characters a day or two in advance of the dramatization.
3. You may elect to have the students memorize their parts. This is not necessary, but helpful for other students to better understand the lesson.
4. Rehearse the sections briefly as you see fit.
5. Perform each part and go through the discussion questions between each dramatic section to make the point that there are ideas here beyond dramatic expression.

"Here Today, Still Here Tomorrow"



Part 1: "Before Treasure Existed"

Cast

Narrator: A reader to set the scene
Thor: The provider for the cave
Mim: Keeper of the cave and Thor's wife
Junior: The couple's 12-year-old son
Pedra: The old woman who lives in the cave next door

Narrator: We're somewhere in England more than ten thousand years ago. It's summer; the weather is cool and cloudy. Thor and his son Junior are returning to the family cave. Thor's wife, Mim, and Pedra, the old woman who lives in the cave next door, are stretched out on a bear skin rug.

Mim: I'll tell ya, Pedra, things have been tough ever since Junior lost our hunting spear in that antelope.

Pedra: They didn't find it, huh?

Mim: No, and it was a good hit, too. They tracked that antelope even after it got dark, and some the next morning. But no antelope, and no spear.

Pedra: An antelope would have been good, huh? All that meat to eat, and meat to dry for later, and the hide for a new coat and moccasins for everyone, maybe, and the bones...

Mim: To lose the antelope and the spearhead...Poor Junior, he feels terrible. Thor's been working hard trying to make a new spearhead, but it's slow work. A chip here, a chip there. Then the stone breaks, and he has to start all over again.

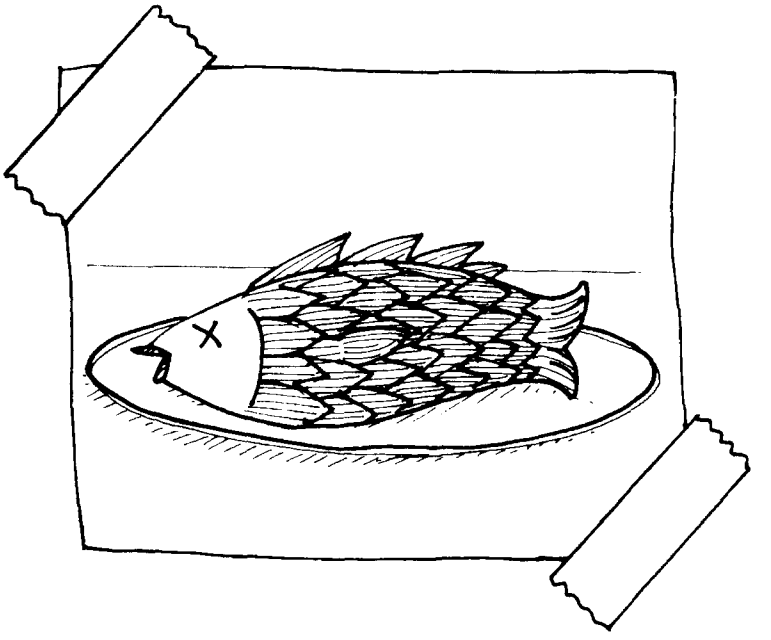
Pedra: I know what you mean. I remember the time my Gibb, may he rest in peace, lost our spear. It was winter. He had his chipping stone, but he had to dig in the snow to find his stash of spearhead rocks. We didn't eat for four days. The streams were frozen. Every animal was in its den. I told him, Gibb, make more spears, have some ready in case you lose one.

Mim: What a good idea. You don't have just one, you have ten.

Pedra: Yeah, but would Gibb listen? He'd wave that big meaty hand of his at me and say, "My father said 'waste not want not.' And that's good enough for me."

Mim: Still, it's a good idea. I'll talk to Thor. Here they come. I can smell them. Maybe they've trapped something. A rabbit. Maybe a grouse. Wouldn't a nice, tender grouse taste good?

(Thor comes marching into the cave with Junior at his heels carrying a huge fish.)



Thor: Here we are. Hello, Pedra.

Junior: Here's dinner, Mom! (He slaps the fish into her lap.) And I picked these berries for dessert!

Mim: That's just great, Junior. Look at that fish. And I needed some fine needles for sewing. Now go out to the wood pile and get me some logs for the fire.

(Junior goes off.)

Thor, would you get me the cutting rock? Pedra, you'll stay for dinner?

(Pedra nods.)

Narrator: (With the family in the background eating.) Mim and her family used and saved everything they had. People made everything from nature, including their clothing, foot coverings, knives, spearheads, needles, thread. You name it, it came from animal or rock, tree, bush, or grass. The loss of an important tool could mean hardship, starvation, even death. But as you'll see, nothing is ever lost forever.

Discussion Questions

What does this tell us about how people once lived?

They lived very simply in caves and ate what they could catch and kill.

What did they throw away?

Very little. They used almost everything they had and left the scraps for wild animals.

How did they use the items they had?

- They used bones and stones for tools; they used wood for cooking and heating their cave.

What materials didn't the play mention that they probably used regularly?

Leaves, grass, teeth, bark, insects, reeds, flowers, herbs, intestines for bow strings, hemp for rope, logs for boats.

What makes it hard for us to use our resources in the same way?

In many cases, we have found other materials that last longer than the materials people used years ago.

Now, let's go on to the next part of the play. We'll see how people in cities hundreds of years ago threw away their garbage.

"Here Today, Still Here Tomorrow"

Part Two: "One Maid's Trash is a Princess' Treasure"

Cast

Narrator: A reader to set the scene
Marie: A princess who lives in a palace
Felix: Commanding Officer of the army
Joe: The palace guard
Brenda: The palace chamber maid (cleaning person)

Narrator: It is Medieval times. The year A.D. 1350. There is no electricity, no plumbing, and no garbage collector. On this sunny, hot day, Princess Marie is going horseback riding with Sir Felix, Commanding Officer of the army. Joe, the palace guard, is letting the couple out by lowering the drawbridge over the castle's moat. As they cross the drawbridge, Brenda, the chamber maid, throws a bucket of slop and dirt out of the second story window. The slop hits Joe on the head and the dirt sprays over Commander Felix and Princess Marie.

Joe: (Shouting.) Brenda, why don't you watch where you're throwing your garbage!

Brenda: (Yelling from the window.) Where else should I throw it? We always throw it out the window.

Joe: Well, you hit the Princess. You could hurt someone.

Brenda: Oh, my goodness. Princess Marie, I'm so sorry. I didn't know.

(Felix and Marie jump down from their horses.)

Marie: That's OK, Brenda. What else can you do with that stuff? (Picking up a long flat stone.) Say, what's this? It looks like a knife made of stone.

Felix: I think it's a spearhead. It may be thousands of years old.

Marie: Really? How did it get here?

Felix: I don't know. Maybe it was left here long ago. Or maybe it got lost. Some hunter lost it killing a wolf. Maybe Brenda cleaned it up and didn't notice it.

Marie: Whatever. I really like it. I'm going to keep it. Something this old that lasts this long is valuable.

Narrator: Marie and Felix are right. The stone is part of a tool - a spearhead - that has been around for a very long time. Materials like stone and metals are very durable. They last a long time.

(Another bucketful of slop and dirt flies out the window.)

Joe: Brenda!

Marie: Maybe this isn't the best way to get rid of this stuff...

Discussion Questions

Where did the spearhead come from?

It could be the one Junior lost in part one of our story.

What would happen if we all threw our trash out the window?

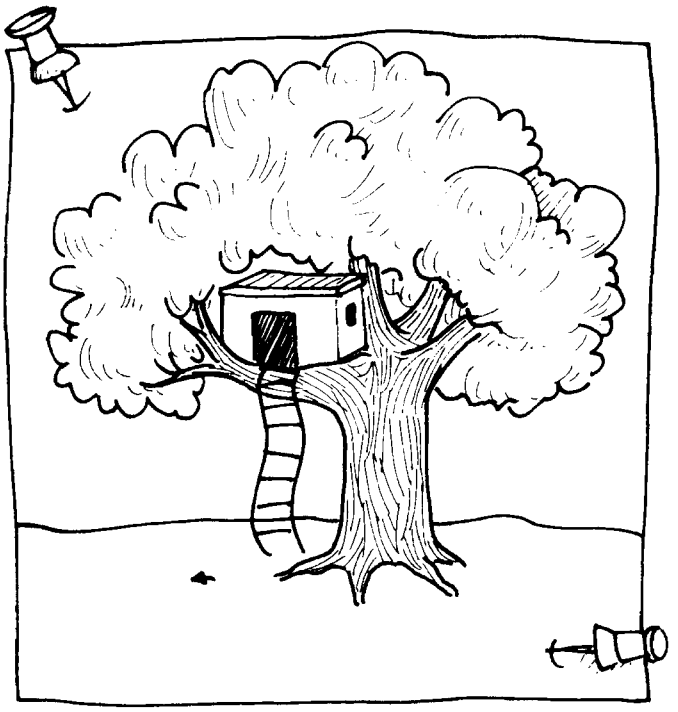
If everyone threw their trash out the window, our cities and towns would look like garbage dumps.

Is it healthful to throw trash out the window? Why?

No, it's unhealthy and it's ugly. Trash often contains decomposing food scraps, broken bottles, and rusty cans that are harmful to our health. Trash must be handled carefully. Today, most of our trash is sent to landfills, some goes to waste-to-energy plants. Organic waste can be used for composting and recyclables can be sent to collection or recycling centers.

Let's see what happens when we don't dispose of our trash properly

"Here Today, Still Here Tomorrow"



Part 3:

"Treasures Under the Tree House"

Cast

Narrator: A reader to set the scene
Dad: A handyman with two children
Justin: Dad's 10-year-old son
Sarah: Dad's 12-year-old daughter

Narrator: Dad and his wife, Judy, live in the country. Dad's children, Justin and Sarah, have been begging him to help them build a tree house in a big old oak tree near the house.

(Dad and Justin enter the scene talking.)

Justin: Here, Dad, this is the tree. It's got a great view and you can see people coming from all directions.

Dad: It looks good, Justin. We'll have to clear away some of the bushes first, so that you can get up into it.

Sarah: (Lagging behind because she's carrying a shovel.) Phew, can I stop now? I'm pooped.

Justin: Sarah, Dad says this will work just fine! I get dibs on sleeping out here the first night!

Sarah: Give it up, Justin, this was my idea...

Dad: Hey, we're not building anything unless you're willing to share.

Justin: Okay.

Sarah: Okay.

Dad: Give me that shovel, Sarah. I need to dig up some of the brush.

Justin: Hey, look at this.

(Digging in the dirt with his hands, he pulls out a spearhead.)

Sarah: What is it?

Dad: It looks like a spearhead. (He shows it to Sarah.) I think it is. It's probably pretty old. It was chipped out with a chipping stone. Look at the workmanship. It probably took some guy a long time to make this.

Justin: Maybe there's more here. (He digs in the bushes at the base of the tree.) Ouch! Something cut me.

Dad: Come here. I've got a bandanna to wrap it in.

Justin: What cut me?

Sarah: Looks like a bottle or a can. There's lots of 'em here.

Dad: Somebody used this area as a dump. Probably the farmer who owned this place before we bought it. He most likely just dug a pit and tossed in everything he couldn't use.

Sarah: You're right, Dad. There's bottles here, old tin cans, old milking buckets, rusty springs...

Dad: C'mon, Sarah, let's take care of Justin's hand. We'll come out later and clean this mess up. I'll bet we can take the cans and bottles to the recycling center.

Discussion Questions

Where did the spearhead come from?

We know now that it is Junior's lost spearhead.

What does this tell us about our world?

Our planet is alive, growing and changing. It continues to use its resources repeatedly to make new leaves, new grass, new trees, new rivers. Some trash decomposes into dirt or humus, but that takes time. Some things take hundreds of years to break down. We need to take a new look at what we use and how we use it to preserve our earth.

Why would someone throw trash under the tree like that?

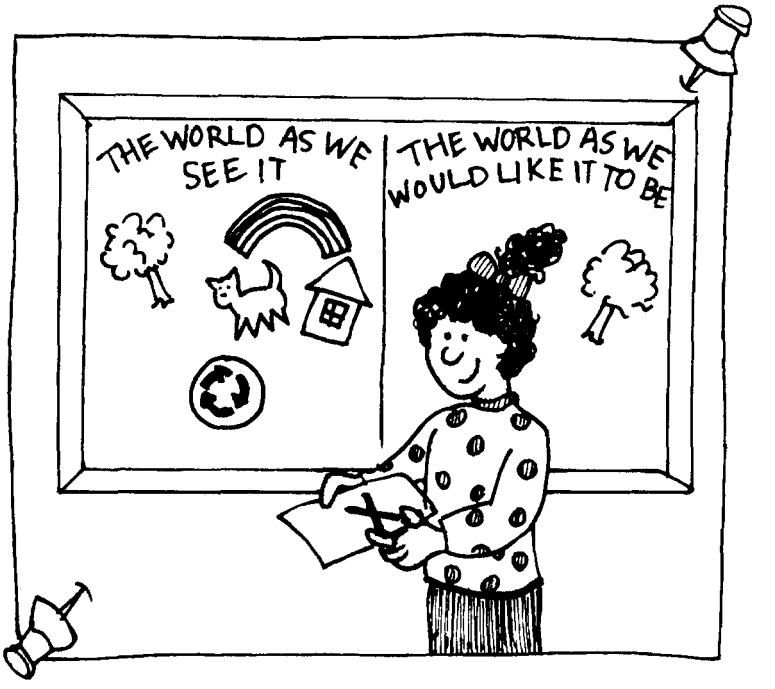
Our attitudes toward trash and garbage have changed repeatedly over the centuries. Farmers commonly wasted very little and because they had a lot of land, they often used a small portion of it for an open dump to dispose of their own trash.

What should we do with our trash?

Items that can be recycled, like aluminum cans, plastic milk cartons and soft-drink bottles, can be separated from other trash and taken to a recycling center. It's important to remember that hazardous waste such as paint cans, chemicals, old medicines, motor oil and many cleaning supplies should be disposed of separately from the rest of our garbage. They can cause harm to our environment if disposed of improperly. Some community governments sponsor household hazardous waste days to collect these wastes for proper treatment and disposal. In Chapter Three, we'll talk about how each of us creates trash every day.

Social Studies / Art Activity

Mural, Mural on the Wall...



Objective

Students will understand the importance of protecting and preserving the environment by constructing a mural, or collage, to identify and illustrate the environment as it is today and the environment as it will appear in the future **if we take care to preserve it.**

Time Needed for Activity

1 to 2 hours

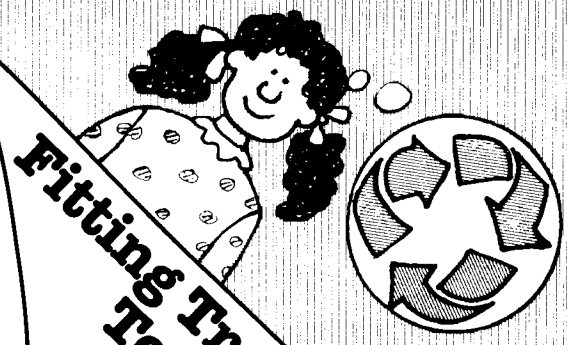
Materials Needed

- Magazines and newspapers that can be cut apart.
- A divided bulletin board with each side labeled to represent the world environment today and the environment of the future.
- Scissors
- Stapler or thumb tacks

Procedure

1. Bring in, or ask your students to bring in, old newspapers and magazines that can be dismantled and cut apart during the exercise.
2. Design and assemble a bulletin board with two halves marked and labeled to correspond to the areas outlined in the objective above. Title the halves: World Environment Today and The Environment of the Future.
3. Explain to and discuss with the students the differences between these areas before the exercise begins.
4. Set aside a time for students to go through the materials collected and put them in the appropriate place on the board.
5. When the collage is complete, ask the students which pictures or words best describe how they feel about the environment, taking care to let them know that they don't have to choose the item they put on the board.

Chapter Three



Fitting Trash into Today

Summary

Applicable to the core subjects social studies and language arts

Discussions and demonstrations that introduce The New 3 R's: Reduce, Reuse and Recycle include:

- an examination of the environmental impact of various types of packaging.
- a demonstration, using a selection of trash, that helps students learn to identify which items in the waste stream can be recycled, reused and/or reduced.
- a "Recycling Quiz Bowl" in which teams of students compete to answer questions about recycling and the environment.

Chapter Objectives

Students will learn how our consumer-oriented economy and each person's daily decisions contribute to the waste problem. By exploring the activities outlined here, students will learn the importance of The New 3 R's. By Reducing, Reusing, and Recycling, they can help solve the solid waste disposal problem.

Chapter Outline

I. **Lesson One:** Where Did the Garbage Problem Come From?
   A. Procedure
   B. Teacher Background
      1. Introduction to the issue
      2. Our dependence on convenience
      3. Single-use items have replaced reusable ones
      4. Many reusable materials are often wasted
   C. Demonstration
   D. Class Discussion

II. **Lesson Two:** How Can We Reuse Some of Our Resources?
   A. Procedure
   B. Class Discussion

III. **Activity**
   A. Recycling Quiz Bowl

Chapter Three
Lesson One

Where Did the Garbage Problem Come From?

Concepts and Skills Addressed:

Problem solving
Class discussion
Listening skills

Materials Needed

A variety of consumer products that students can examine and discuss in class. Examples include:

- a package of chewing gum
- a complete pizza mix with crust, sauce, and cheese
- a complete cake mix
- a two-liter, plastic drink bottle
- a wrapped, men's shirt
- a shampoo bottle
- a plastic ice cream tub
- a watercolor paint set
- an empty pickle jar

Students will learn how our demand for convenience sometimes leads to excessive packaging, which contributes to our waste problem. They will observe how we can avoid wasting some resources on single-use items by Reducing, Reusing and Recycling - The New 3 R's.

A. Procedure

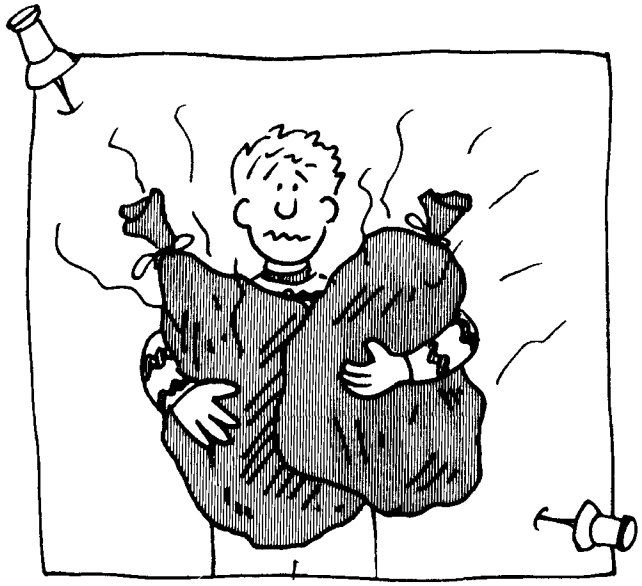
1. Read the "Teacher Background" section.
2. Divide the class into groups and hand each group a product to examine.
3. Encourage the groups to dismantle their products and speculate what the packages are made of.
4. Talk through the discussion questions as a class.

B. Teacher Background

1. Introduction

As we have seen in Chapter Two, prehistoric societies made the most of their resources. Remember the cave dwellers who used almost every part of the animals they killed? Later, we met a 10-year-old boy who was cut by broken glass in what was an open dump. How did we change from a society that once tried to get the most use out of its resources to one that creates 4.4 pounds of waste per person, per day? The answers to these questions are the basis for this lesson.

2. Our Dependence on Convenience



Modern Western society has used disposable goods at an ever-increasing rate since the 1950s. This trend evolved as an indirect result of the rapid growth of big industry during the first half of this century, which in turn triggered developments in technology. In the post World War II era, the United States and Canada experienced growing urban and suburban populations; a shift from single income to two income households with more buying power; and, finally, a greater need for and dependence on convenience and speed in home care and grocery supplies.

Life in the city created the need for supermarkets, mass merchandise stores, and discounters. To help service and attract customers, merchandisers developed thousands of new products and invented thousands of ways to contain them. Pre-packaged food, for example, was convenient for both shoppers and retailers. Shoppers could now choose their groceries and sundry goods quickly, in pre-measured, pre-packaged forms. For the manufacturers and store operators, this new trend in merchandising meant easier storage of large shipments, better health standards, better inventory control, and less damage. This increase in packaging created an enormous demand for paper, plastic, glass, and metal products, and put a steadily growing burden on the **waste stream**, but much of what is currently seen as waste can be reused and recycled.

Another factor that has added to the growing waste stream is that items normally considered repairable or reusable are now considered disposable. A portable stereo, for example, may cost the same, or more, to repair as it does to replace. Other items have become disposable as well, including medical syringes, cameras, radios, and watches. Statistics reveal the changes contributing to the solid waste disposal problem in North America. The amount of solid waste generated per person per day since 1960 increased nearly 66 percent, from 2.65 pounds to 4.4 pounds in 1993. This increase can be attributed to a growing reliance on convenience items: convenient for use and convenient for disposal. Along with this trend, of course, the population has increased.

3. Single-use Items Replaced Reusable Ones

Items that are used once and thrown away have replaced reusable items. There are many examples of this change. Years ago, a milkman came to the doorstep, collected empty glass bottles, and replaced them with full ones that had been sterilized and reused. Today, people go to supermarkets to buy milk in cartons made of plastic or coated foodboard. Many of these can now be recycled.

4. Many Reusable Materials are Thrown Away too Soon

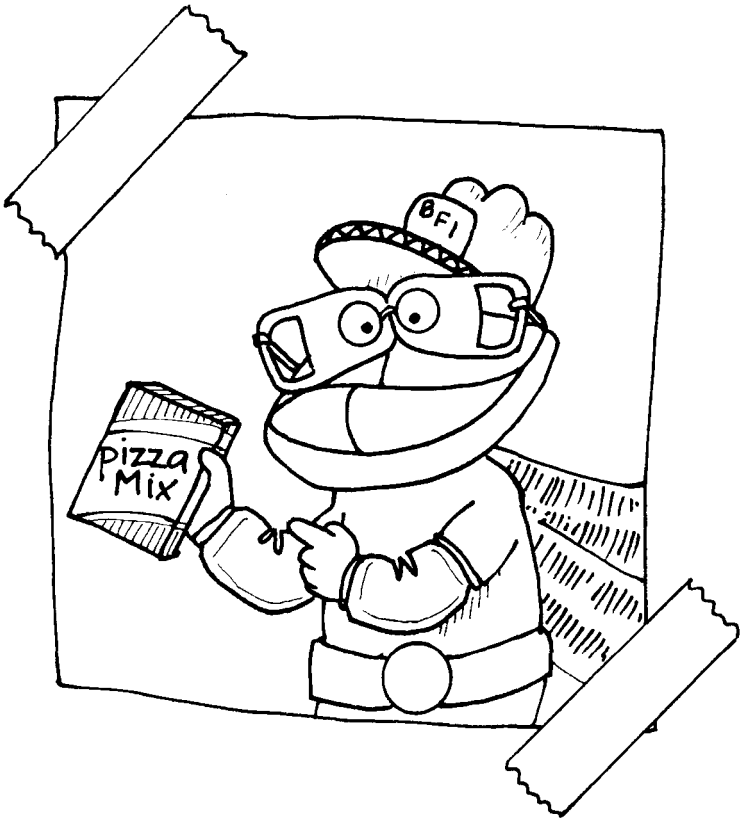
While many of the products we buy come in nonrecyclable packages, we are throwing away too many products that contain materials which could be reused or **recycled**. Glass jars and bottles, for example, can be recycled and made into new containers; newspaper can be recycled and made into new newsprint and other paper products; aluminum and steel cans can be recycled and made into a variety of new products, from new cans to engine parts; today's recycled plastic soft drink bottle may become tomorrow's living room carpet, etc. Products made of paper, aluminum, steel and plastic can be reused and recycled many times before they must be thrown away for good.

Recycling is one clear option to controlling waste disposal and one in which we can all participate. More and more people are realizing the need for this environmentally sound waste-disposal option, and more and more communities are participating in recycling programs. In addition, manufacturers continue to explore ways to create **degradable** and **biodegradable** products as possible components to the solution, and scientists and researchers around the world continue to look for a balance between society's need for convenience and environmental safety. Ultimately, the solution will need to be an integrated waste disposal system - one that includes recycling, waste-to-energy, landfilling, and composting.

By becoming better educated consumers and increasing our efforts to reduce, reuse and recycle, we, as individuals, can play a positive role in meeting the waste disposal challenge. Our combined efforts can and will make a difference.

C. Demonstration

Let's look at what we put into the waste stream. Although there are many ways we add to the waste problem, MOBIUS suggests we take a look at the different ways things are packaged.



1. Let's take a look at the items given to each group.

(Teacher examines an item and asks that the students answer some questions as a group.)

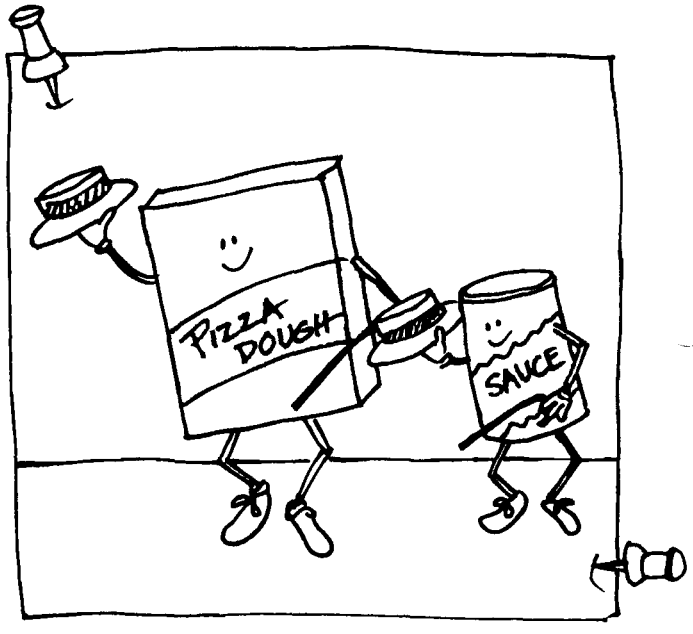
MOBIUS asks:

- Why is this thing packaged this way?
- We're using many kinds of packages and only some of them can be used again. Can you show me a less wasteful way to package this item?
- With this new way, are you giving anything up? Freshness? Convenience? (Remember, some items are not food.)
- Perhaps some containers can be used again for the same or new purposes. What are some of these ways?

D. Class Discussion

If all of your families made pizza from a box tonight, how many packages would you be throwing away? (Box, dough package, sauce can, cheese packet, etc.)

- How many of these packages are recyclable?
- How much trash would we have to throw away after we took out the recyclables?
- Could we make enough pizza for everyone in this room with one package? (The package usually lists the serving size.)
- What would be the best way to make pizza for the whole class? Should we buy all the ingredients separately or buy the prepared package?
- Which way costs less?
- Which way wastes less?
- What about the other items?
- What part of these items can be used again, or recycled?
- What cannot be used again and must be thrown away?
- What new ways could these items be packaged using less waste?
- What ideas did your group have to make use of the reusable parts of your item?



Chapter Three Lesson Two

How Can We Reduce, Reuse and Recycle Some of Our Resources?

Concepts and Skills Addressed

Social science
Recycling awareness
Arithmetic

Materials Needed

Trash bag filled with (clean) recyclable and nonrecyclable items weighing about 4.4 pounds (2 kilograms)

Materials Supplied

Glossary of terms
Discussion questions and answers

Students will learn ways in which they can contribute to reducing waste by recycling items found in trash as well as reusing certain items and thereby reducing the trash they are producing.

A. Procedure

1. Place students in groups of two.
2. Ask each question and give students time to listen to each other's answers.
3. At random, call on students to tell the class how their **partner** answered the question.
4. Continue this process, or begin addressing questions to the class as a whole group.
5. At the appropriate time, introduce the bag of throw-away items and discuss the following questions.

B. Class Discussion

What can we do to reduce the amount of trash we create each day?

Answer: We can help reduce the trash we create by reusing items we are now throwing away, recycling many of the resources in our trash, and by buying products that indicate they are recyclable and recycled.

REDUCE, REUSE, RECYCLE - THE NEW 3 R's

Is it important to recycle? Why?

Answer: Yes. By recycling we will reduce the amount of trash each one of us produces each day, and lessen our dependence on landfills and other waste disposal methods. We will help to preserve our natural resources because we won't be using as many virgin raw materials to make new things.

(Teacher introduces bag of recyclable and nonrecyclable items.)

Look at this bag of trash. Does it seem like a lot?

Answer: It's not a lot by itself, but on average, EVERYONE generates about this much trash each day. Numbers vary but our sources say approximately 4.4 pounds was created by each person in the United States, each day, as recently as 1993.

If each of us makes 4.4 pounds of trash each day, how much does that mean our class is responsible for creating each day?

How much do all the students in our school throw away each day?

How do you think the number 4.4 pounds was calculated?

Answer: The total amount of tons of municipal solid waste generated in the United States in 1993 was divided by the total U.S. population and by 365 days (the number of days in a year), then multiplied by 2000 pounds per ton.

Will that number ever change? Why?

Answer: The number could change and it could go up or down, but, for the first time, the Environmental Protection Agency projects a decrease of per capita generation - to 4.3 pounds by the year 2000.

Various source reduction activities are expected to have a positive influence on reducing the waste stream. Increased composting efforts and leaving grass clippings on lawns have resulted in less yard trimmings entering the waste stream. Other factors include the effort to reduce packaging, increased government regulations that lead to these actions for more than half of the U.S. population, and increased efforts on the part of everyone to reduce, reuse and recycle.

What are some of the ways we could reuse our trash or reduce the amount of trash we create?

(Use the items in the trash bag and/or additional items. Spread these out on a table or pass out an item to each student or group of two students.)

Examples of reducing or reusing:

- Use rechargeable batteries; they also reduce our trash. Substitute canvas shopping bags that can be used over and over instead of using paper and plastic. If you do use paper or plastic, find out if you can return them to your grocery store for recycling.
- Use cloth towels instead of paper towels.
- Old clothes make good cleaning rags.
- Buy large containers of soft drinks, instead of many small ones, and use a reusable thermos bottle for individual servings.
- Take a lunchbox, instead of a paper sack.

Can you think of any other items in your trash at home that could be reused?

What is one way we can tell if a product can be recycled?

Answer: We can look on the product's package or container for the recycling symbol.

What are two ways people can participate in recycling?

Answer: We can separate our recyclables, like newspaper, plastic milk and soft drink bottles, glass and aluminum items and have them picked up through curbside collection programs. When curbside collection programs are not available, we can collect and separate our recyclables and take them to a collection or recycling center, when these resources are available in our community.

What about other types of recyclables? How can we cut down on the amount of paper we use?

Answer: Buy fewer products packaged in nonrecyclable containers, or containers not made from recycled materials. When possible, use both sides of sheets of paper, etc.

Recycling aluminum cans is a common practice for many of us. Do you know why?

Answer: The aluminum manufacturing industry has encouraged aluminum recycling since the mid 1970s by establishing convenient recycling centers in many communities across the country. People who bring aluminum to these centers are often paid for their efforts, which encourages them to do it again. The same is true for newspapers through paper drives.

When we recycle glass, does it matter that the containers are different colors?

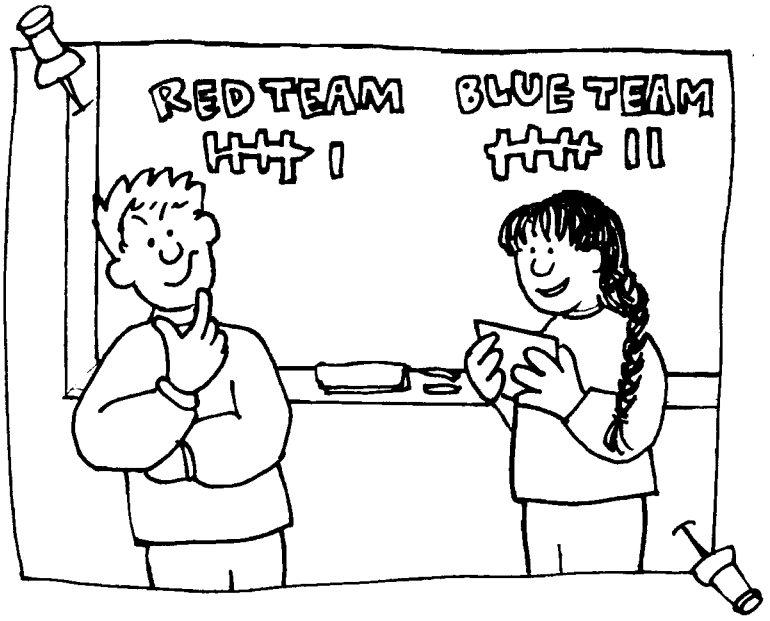
Answer: Yes. Each type of colored glass must be recycled separately to make sure that clear glass remains clear, green glass remains green, etc. If the glass is separated before it goes to the recycling center, the people who buy this material will pay more for it.

What can we do in the future about materials that must go to a landfill?

Answer: We can find ways to make these materials useful and valuable by finding new ways of recycling them that are safe for the environment. In Chapter Four, we will look at the big picture: How both recyclables and nonrecyclables and the trash each of us creates each day fit into the only world we have to live in.

Science
Math
Social Studies
Language
Activity

Recycling Quiz Bowl



Objective

Students will more fully understand the concepts of recycling and environmental protection by playing a Quiz Bowl-style game.

Materials Supplied

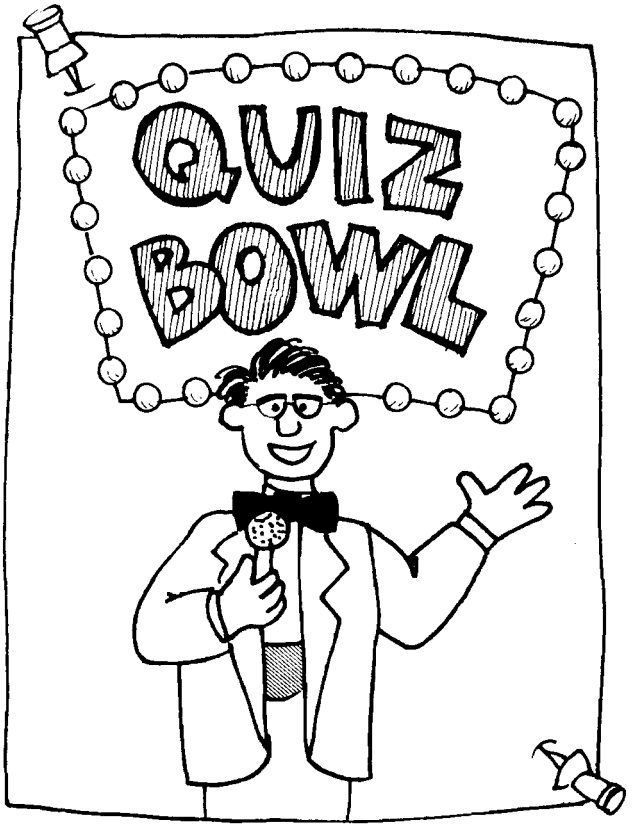
Data comprised in the MOBIUS Curriculum: Understanding the Waste Cycle, Sample Questions

Materials Needed

Paper, pencils, chalkboard for scoring, timer or clock

Procedure

1. The object of the game is to score points by answering questions correctly. The winner is the team who has accumulated the most points after the bonus question.
2. Divide the class into two teams, Team A and B, or give them names.
3. Move students and desks to accommodate the teams. Students may be responsible for coming up with answers individually, or they may take turns giving answers after discussing them as a group.
4. Write quiz questions for the teams or have the teams write them for each other. You will need a total of about 20 to 30 questions (10 to 15 per team).
5. Teams alternate answering questions within a time period you designate.
6. Choose a facilitator and scorekeeper (teacher, student).



How to play

1. Determine which team will go first.
2. Team A draws a question. The scorekeeper reads it. Team A then has a set time period to formulate an answer, either individually or through discussion. The team must answer by the end of the designated time period. Then it is Team B's turn.
3. If questions are compiled by the instructor, you may give teams the option to pass two questions per game to the opposing team. If Team A passes a question to Team B, Team A must draw and answer the next question and Team B must answer the question passed to them on the next turn.
4. This part of the game is timed to last 15 minutes.
5. After 15 minutes, a bonus question is asked. Before it is asked, both teams write down how many points they will wager on the final question. If they wager two points and answer correctly, they add two points to their score. Likewise, if they answer incorrectly, they lose two points. The team cannot wager more points than they have won. The teams have two minutes to come up with their answers to the bonus question.

Scoring

Score two points for a correct answer and zero points for an incorrect answer or no answer.

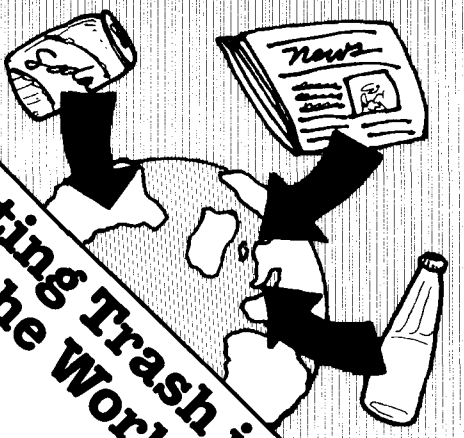
Optional Activity

Quiz Bowl could be presented in a television game show format with a host and commercials on recycling. Example: "Good afternoon, I'm your host, (name), and this is The Garbage Game!"

Suggested Quiz Bowl Questions (Try writing some of your own!)

1. How much trash does each person generate or create daily? (approximately 4.4 pounds or 2 kilograms)
2. What is the main ingredient in paper? (wood pulp)
3. What material makes up 29.4 percent by weight and 32.1 percent by volume of a landfill? (packaging)
4. What is the main ingredient in glass? (silica, or sand)
5. What is a material that can be made from recycled plastic? (carpet, lumber, insulation, pot scrubbers, etc.)
6. How much of our trash could we compost if we had a back yard compost pile? (approximately 16%)
7. What percent by volume of the trash in landfills is plastic? (23.9 percent is plastic)
8. What is the most common form of waste disposal? (landfills)
9. What kinds of waste disposal facilities can be built to create electricity? (waste-to-energy plants and landfills)
10. What is the name of the man who invented the Mobius strip? (Augustus F. Mobius)
11. What are a few examples of new things made from recycled paper and/or cardboard boxes? (egg cartons, cereal boxes, cardboard, packing material, etc.)
12. What are The New 3 R's? (Reduce, Reuse and Recycle)
13. What are the four ways to dispose of trash in an integrated waste disposal system? (landfilling, waste-to-energy, composting, recycling)
14. Are open dumps the same as sanitary landfills? (no)
15. What is disposed of in an ashfill or monofill? (ash from waste-to-energy plants)
16. What is the rich material created by composting? (humus)
17. What are three things that we use everyday that can be recycled? (newspaper, aluminum beverage cans, soup cans, glass and plastic soft drink bottles, glass jars, plastic milk cartons, paper, paper and plastic sacks)

Chapter Four



Fitting Trash into the World

Summary

Applicable to the core subjects science, mathematics, social studies and language arts

Included are:

- a practical math exercise that involves examining a ton of trash and the percentages of raw materials that make up the waste stream
- an examination of the raw materials that shows how resources can be saved through recycling activities that offer students the opportunity to become editors, art directors and reporters while writing and producing a newspaper on recycling and the environment.

Chapter Objectives

In this chapter students will explore their connection and contribution to the waste disposal problem by looking at the contents of a ton of trash. They will compare the amount of raw materials needed to make certain products to using recycled materials for the same products. Students will examine plastic as a special case, observing its role as a reusable and recyclable material.

Chapter Outline

I. **Lesson One:** "It Weighs a TON!"
   A. Procedure
   B. What's in a Ton of Trash

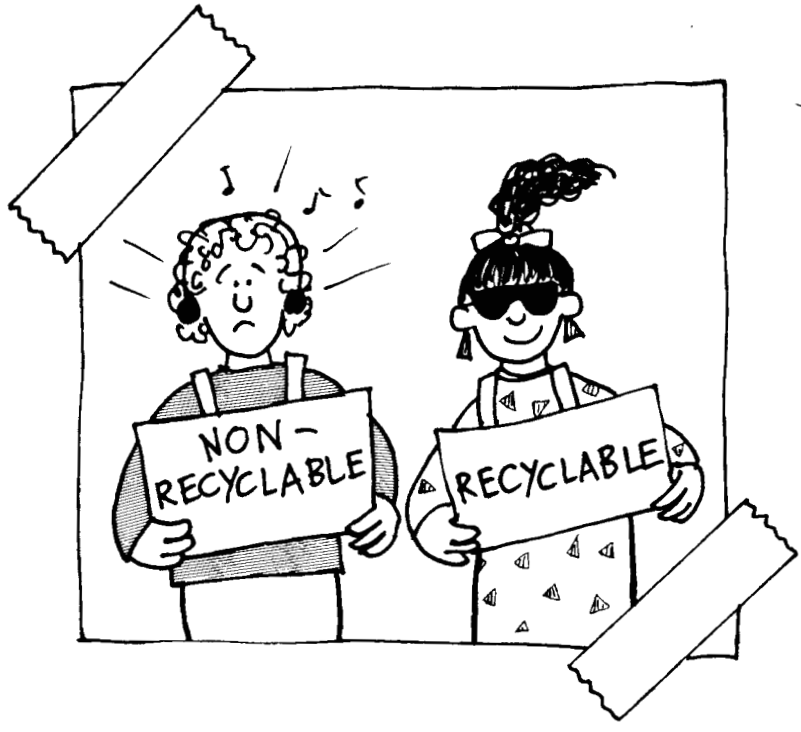
II. **Lesson Two:** What it Takes to Make a Ton
   A. Procedure
   B. Raw Materials and Recycled Materials
      1. Paper
      2. Glass
      3. Aluminum and other metals

III. **Lesson Three:** What About Plastic?
   A. Procedure
   B. What About Plastic?
   C. MOBIUS Considers His Options

IV. **Activities**
   A. Recycling Times...Herald...News...Post
   B. Radio Waves Teach Recycling Ways

Chapter Four
Lesson One

"It Weighs a Ton!"



Concepts and Skills Addressed

Social Science
Problem Solving

Materials Needed

None

Materials Supplied

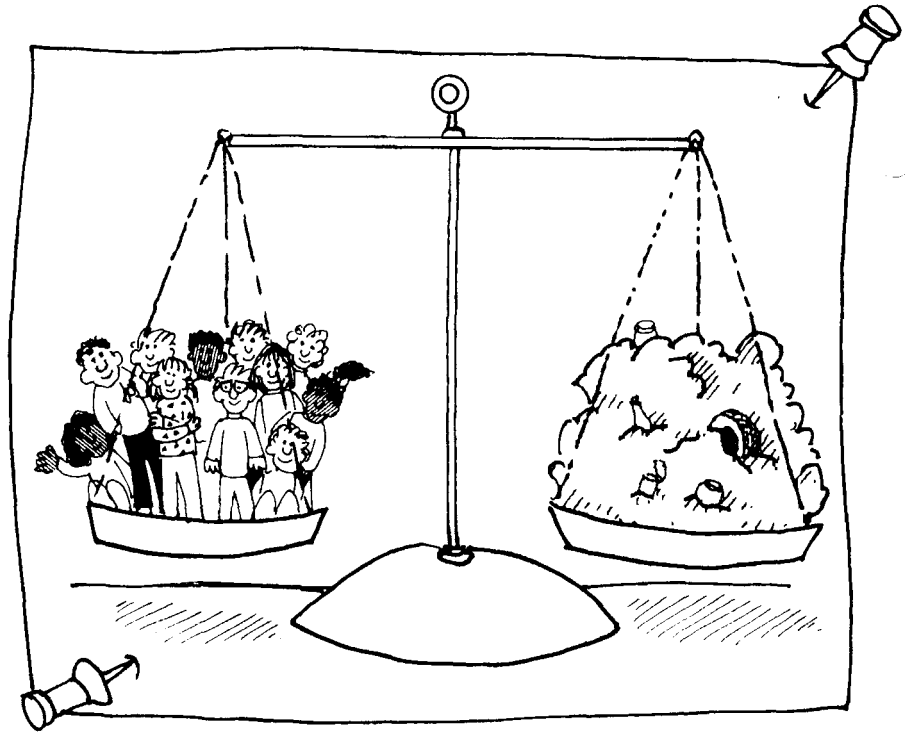
None

Students will learn how the trash each of us creates daily builds quickly into a huge pile. They will learn the concept of a 'ton,' and will then learn what comprises a typical ton of trash. They will explore some of the ingredients that make up many commonly recycled products, and which raw materials can be saved by recycling those products.

A. Procedure

1. Explain how much a ton weighs by using the information provided in the following pages.
2. Determine how much your class weighs collectively. (For continuity's sake, call it a ton and use your students as the example.)
3. Divide the group into the percentages indicated in the information given here and tell each group the name of the category they represent (e.g. glass, paper, plastic, etc.)
4. Ask each group if the material they represent is recyclable. If it is, move them to a designated 'recyclables' area you've already established. Find some way to ensure that they remember what group they're from, they'll need to know in later lessons. Have the groups make name tags or signs to indicate what materials they are. (The point is that there is always a percentage of recyclable waste that is not recycled.)
5. Once each group is divided into recyclables and nonrecyclables, you should have the paper, glass, metals, food, plastic and yard waste groups in one area - roughly 80 percent of your class, with the rest of the class representing the non-recyclables. (Some of the items that currently cannot be recycled include light bulbs, waxy paper products, used paper towels and tissues, toothpaste tubes, leather and most textiles.)
6. Explain to the students that if we recycled all of the items that are recyclable in our trash, we could reduce the amount of waste sent to landfills by as much as we reduced the size of the group. Then move on to Lesson Two and explain how raw materials and natural resources can be saved by recycling.

B. "It Weighs a Ton!"



What is a ton?

A ton is 2,000 pounds (lbs.). That means that if each student weighs 80 pounds, it will take 25 students to make a ton. (80 x 25 = 2,000). A metric ton is equal to 1,000 kilograms. If each student weighs 40 kilograms, it will take about 25 students to equal a metric ton.

What's in a ton of trash?

By weight, a typical ton of trash in America is comprised of:

37.6 percent paper. Americans use about 600 pounds (272 kilograms) of paper and paperboard per person per year. We typically recycle about 34 percent of what we use. The paper industry has set a goal of 50% recycling by the year 2000. (On the blackboard, make a list of paper products that can be recycled but are often thrown away. For example, newspaper, school work, wrappers, cardboard boxes.)

6.6 percent glass. Currently we recycle 22 percent of the 13.7 million tons (12.4 million metric tons) of glass generated each year. Although we're getting better about reusing this resource, there is much more that we could do. (Continue your list with items made of glass that can be recycled. For example, food jars, beverage bottles.)
NOTE: Some specialty glass is not widely recycled. Examples include light bulbs, window glass and mirrors.

8.3 percent metal. Metal is one of the most recyclable items in our trash. Metals can be recycled repeatedly. (Other recyclables, like paper, will eventually break down, which means the **wood fibers** that paper is made of get shorter each time the paper is recycled. Recycled paper usually is mixed with wood pulp to assure a good quality paper product.) (Besides beverage cans, what other metal items do we use that can be recycled? Food cans, bottle tops, old appliances, bicycles, garden equipment.)

6.7 percent food waste. List various food items thrown away. Could these items be recycled? How about feeding it to farm animals and composting?

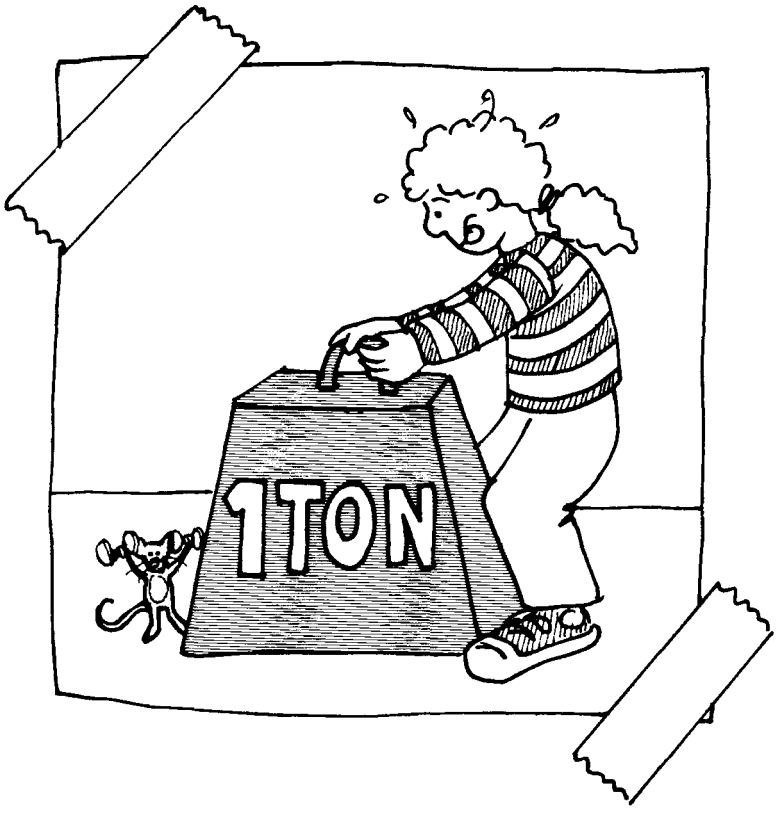
9.3 percent plastic. 19.3 million tons (17.5 million metric tons) of plastic are generated each year with .68 million tons (.62 million metric tons), or 680,000 tons (616,760 metric tons) recycled. It is important to note that by volume plastic makes up 23.9 percent of landfill trash. Many plastics can be recycled. The number of different types of plastic used makes recycling somewhat difficult because although they are all plastic they must be separated into each type to be recycled. For example, plastic soft drink bottles are a different type of plastic than plastic milk cartons, and the plastic that is recycled from them is used to make different kinds of products. New uses for plastic are being found all the time and the plastics industry is researching new technologies for separating and processing recyclables. (List plastic items that are thrown out. For example, shampoo bottles, laundry soap containers, milk bottles, beverage containers, plastic wrap and bags, food wrappers.)

15.9 percent yard waste. Yard waste can be placed in a compost pile, along with other organic materials such as food scraps, and left to decompose naturally. The resulting humus can then be used in gardens and on lawns as a rich, natural soil additive. Many states is the U. S. have laws proposed or in place banning yard waste from landfills. (List yard wastes typically thrown away. For example, fireplace ashes, grass clippings, leaves, weeds.)

15.6 percent miscellaneous trash. This category includes items that don't fit into the above categories. Many of these items can be recycled or reused but the amount recycled is small compared to the other categories. (Recyclable miscellaneous items include rubber and leather, textiles, wood, and other **inorganic** waste.)

Chapter Four
Lesson Two

What it Takes to Make a Ton



Concepts and Skills Addressed

Social Science
Problem Solving

Materials Needed

None

Materials Supplied

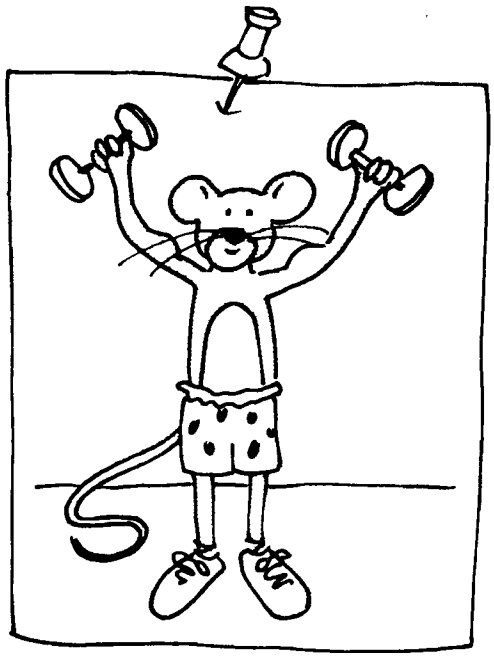
None

Students will learn how raw materials and our resources can be preserved through recycling.

A. Procedure

1. Read through the material "What it Takes to Make a Ton," which follows.
2. Divide the class into four groups: one for paper, one for glass, one for aluminum and one for steel. Give each group the list for their category of the "Resources Saved by Recycling."
3. Ask each group to discuss briefly how saving these resources can benefit the world.
4. Designate a writer in each group to jot down the ideas and to tell the rest of the class the resources that are preserved and how that benefits the world.
5. At the end of the discussion explain that there are other recyclables you have not yet talked about (namely yard, and food waste) and that you'll talk about some of these things in more detail later. (Because there are many types of plastic and many different products made of plastic, specifying the raw materials required for the manufacture of plastic products was not included in this exercise. You can discuss plastic as a separate exercise, using the information provided in "What About Plastic?" in this chapter.)

B. What it Takes to Make a Ton



Making a ton of something equaling 2,000 pounds (907 kilograms), takes a lot of material. We can use either raw materials or recycled materials to make the same items. By looking at the difference between two ways of making the same thing, we can learn how our environment is helped or hurt by our decisions.

To Make a Ton of Bleached Paper

We Use These Raw Materials

- 3,688 lbs. of wood
- 216 lbs. of **lime**
- 360 lbs. of **salt cake**
- 76 lbs. of **soda ash**
- 24,000 gallons of water
- 28 million **Btu** of energy

We Would Have to Treat and Dispose of

- 84 lbs. of air **pollutants**
- 36 lbs. of water pollutants
- 176 lbs. of solid waste

Resources Saved by Recycling Paper

Recycling one ton of newspaper

- is the equivalent of one ton of paper made from about 17 trees.
- conserves three cubic yards of landfill space; that's a box three feet tall, three feet wide, and nine feet long.

To Make a Ton of Glass

We Use These Raw Materials

- 1,330 lbs. of sand
- 433 lbs. of **soda ash**
- 433 lbs. of **limestone**
- 151 lbs. of **feldspar**
- 15.2 million Btu of energy

We Would Have to Treat and Dispose of

- 32.5 lbs. of **mining waste**
- 8 lbs. of air pollutants

Resources Saved by Recycling Glass

If we use a mixture of 1/2 recycled glass and 1/2 raw materials, we reduce

- water consumption by 50 percent.
- mining wastes by 79 percent.
- air pollutants by 14 percent.

To Make a Ton of Aluminum

We Use These Raw Materials

- 8,766 lbs. of **bauxite**
- 1,020 lbs. of **petroleum coke**
- 238 lbs. of lime
- 197 million Btu of energy

We Would Have to Treat and Dispose of

- 3,290 lbs. of **red mud**
- 2,900 lbs. of carbon dioxide
- 81 lbs. of air pollutants
- 789 lbs. of solid waste

Resources Saved by Recycling Aluminum

Recycling aluminum reduces

- water consumption by 95 percent.
- energy use by 95 percent.
- air pollutants by 95 percent.

To Make a Ton of Steel

We Use These Raw Materials

- 1,970 lbs. of iron **ore**
- 791 lbs. of petroleum coke
- 454 lbs. of lime
- 29 million Btu of energy

We Would Have to Treat and Dispose of

- 538 lbs. of solid wastes
- 42 lbs. of air pollutants

Resources Saved by Recycling Steel

Recycling steel reduces

- energy consumption by 74 percent.
- air pollutants by 86 percent.
- water used by 40 percent.
- mining wastes by 97 percent.

Chapter Four
Lesson Three

What About Plastic?

Concepts and Skills Addressed

Problem solving
Listening

Materials Needed

None

Materials Supplied

Teacher/student background on plastic
Questions and answers

Students will examine how plastic fits into our daily lives and will identify plastic items they routinely use. After discussing plastics in groups, students will explain to the class their ideas on how to reduce plastic waste and reuse some of the plastic we now throw away.

A. Procedure

1. Read and paraphrase for your students "What About Plastic." (You may ask them to read the material or you may want to give a short talk on the subject.)
2. Divide the class into groups of three or four and give each group a question or two from those listed here.
3. Ask the students to discuss their ideas as a group and to identify a leader who will act as the group's spokesperson.
4. Note the responses on the chalkboard, then review them.

B. What About Plastic?

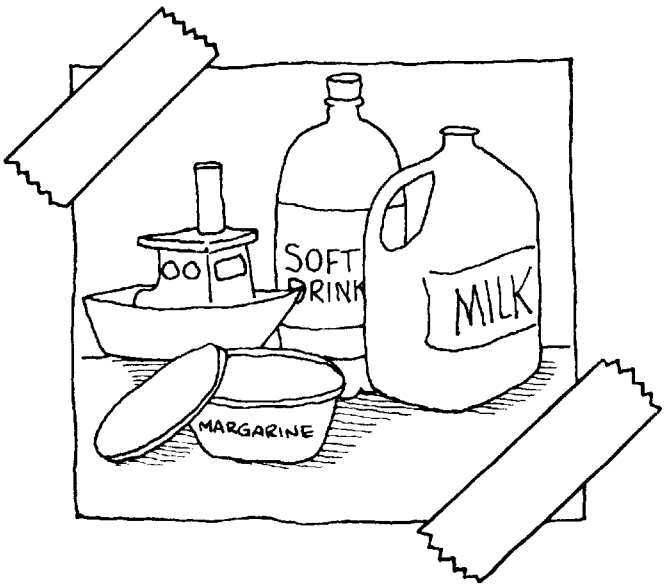
Note to teachers:

Plastic is a general term. Different chemical components make up different kinds of plastic. Generally, each kind of plastic must be recycled separately. And some types of plastic are not recyclable at all. Separating plastic is a problem when there are so many kinds, and when different types are combined to make one container. A shampoo bottle, for instance, may be made of one kind of plastic while the cap is made of another.

We are finding new uses for plastic every day. Meanwhile, scientists and businesses are working very hard to invent new ways to recycle all types of plastic, not just soft drink bottles and milk containers.

Plastic. It's a convenient packaging material. It doesn't cost much or weigh much. It rarely breaks. We like many of the unique qualities of plastic.

But plastic products are often used once and thrown away, and we need to find more ways to reuse and recycle them. In 1993, the amount of plastic trash generated was 19.3 million tons (17.5 million metric tons). About .68 million tons (.62 metric tons) was recycled. That means that about 150 pounds (68 kilograms) of plastic per person is thrown away each year; of that, 5 pounds (about 2 kilograms) is recycled.



But some people still don't know that many plastic products are recyclable and that markets are developing. We need to be aware that in many communities there are curbside collection programs where used plastic such as milk jugs and soft drink bottles are picked up by special recycling trucks on designated recycling pick-up days, along with other recyclable such as paper, glass, aluminum and metal. And in many communities, there are recycling centers that accept certain used plastic items.

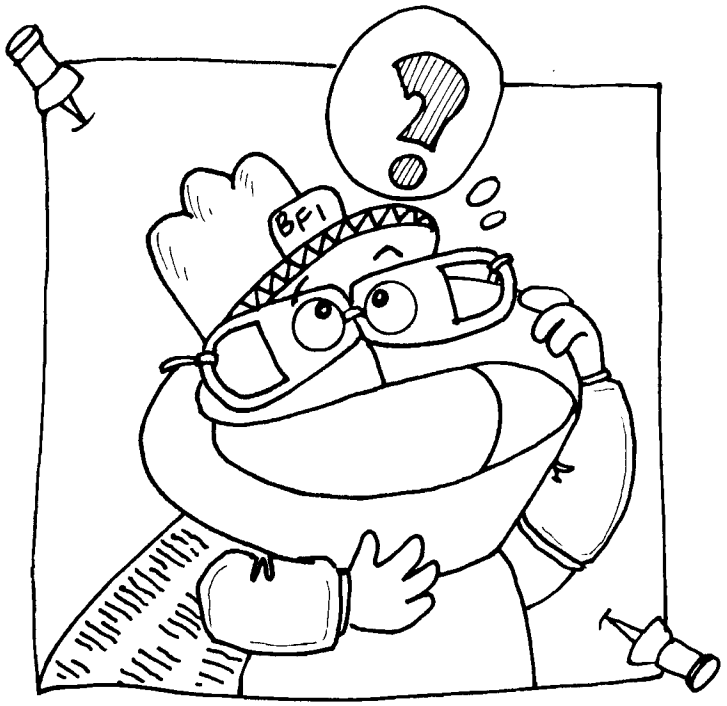
What can we do to help reduce the amount of plastic we generate? We can avoid buying products that are packaged with a lot of plastic. We can also buy one big package instead of lots of little ones so there will be less waste.

How can we reuse some of the plastic items that we often put in our trash? Think about your old plastic toys. If they're broken, you can try to repair them. If they're just used and you don't want them anymore, you can donate them to charity. Now, think about plastic containers, such as margarine tubs. These make great storage containers for food leftovers, art supplies, or things you collect like marbles and rocks. Plastic bags from the grocery store can also be reused, and in some places, you can return them to the store and they will be recycled. And remember, if you use plastic cups and utensils, they can be washed and used again.

What can we do to increase our plastic recycling efforts? We can encourage our communities to start curbside collection programs that include plastic as well as other recyclables. We can find out if there are recycling centers in our community that accept plastic and, if we locate one, we can take them our used plastic. The recycling center will then sell the used plastic to a processing plant or manufacturer who will use the old plastic to make all kinds of new products, from carpeting to park benches.

Plastic is an extremely useful material. But right now we still bury too much of it in landfills where it takes up a lot of room, 23.9% by volume. There is a better way. We need to spread the word that certain plastics are recyclable and increase our own efforts to recycle and reuse plastic products.

C. MOBIUS Considers His Options



Teachers: Many answers to these questions are based on common sense and the materials mentioned in this chapter. Use these questions as a starting point for your class discussion.

Imagine that MOBIUS has come to your classroom today. MOBIUS is asking you to help find answers to these questions:

How does recycling help make the world a better place to live?

How can we develop the recycling habit?

How can we help others do the same?

What are two ways we can recycle?

What are some advantages of plastic packaging?

What can we do to cut down on the amount of plastic we throw away?

What would life without plastic be like?

Is there anything we can do as a class that will help reduce the amount of plastic we throw away?

How can we help people who don't recycle develop the recycling habit?

Language/ Art Activity

The Recycling Times... Herald... News...Post...

Objective

Students will write and produce a newspaper for their class, school, or community on recycling and the environment. They will have a chance for independent or team study in specific subjects that interest them, to spread the word about recycling, and to gain firsthand knowledge of the many aspects of newspaper production.

Time Needed for Activity:

One to four weeks, depending on length of the newspaper

Materials Supplied:

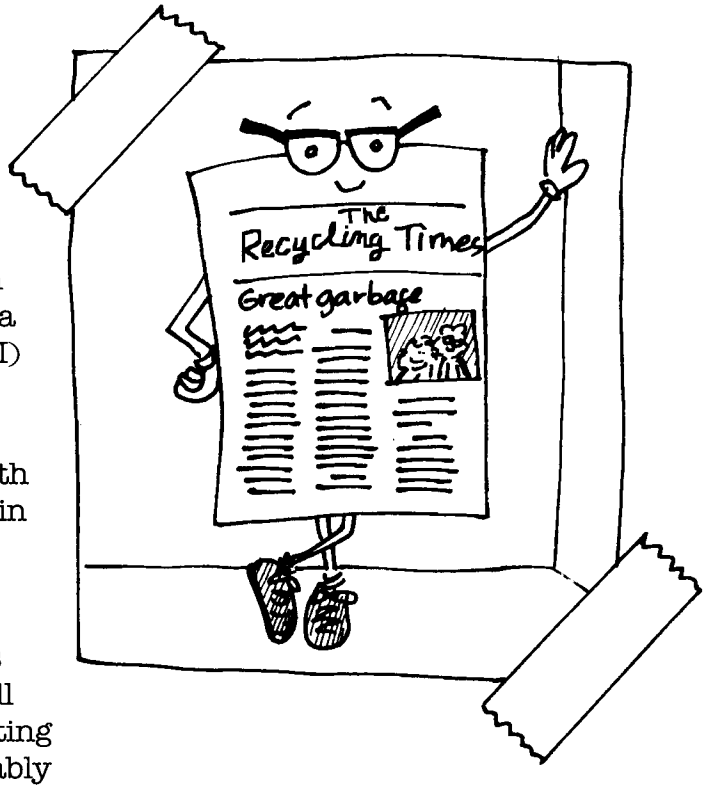
Planning worksheet

Materials Needed:

Paper, pencils, scissors, glue stick or spray, roller (rolling pin will work), cardboard or posterboard, and copying facilities

Procedure

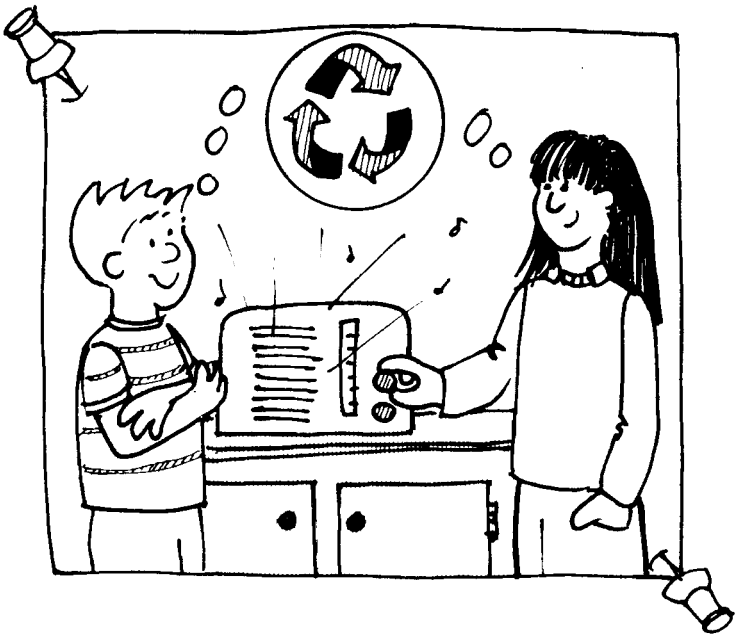
1. Discuss with the class all aspects of producing and distributing a newspaper, as explained here. You may want to arrange for the editor of your local newspaper to speak to your class.
2. Work with students to develop a statement of purpose for the newspaper that answers, "What is the reason for this newspaper?" and "Who will read it?"
3. Brainstorm and then vote on a name for the newspaper.
4. Divide the class into teams: an editorial team (writers, researchers), an art team (illustrators, photographers, and/or picture collectors), a production team to design the banner and manage the layout and printing of the newspaper, and an advertising team that will help sell and create ads. The ads may be placed free of charge or for a nominal fee to cover printing costs. "Customers" for advertising can be role-played by class members.
5. Using the worksheet provided, devise a story list and assign tasks and deadlines. Suggested components:
   - Feature story, such as what the school, the cafeteria, or the community, is doing to promote recycling
   - Cartoons or a comic strip
   - A crossword puzzle
   - Photographs
   - An interview or advice column (an interview could be conducted with a recycling expert, possibly from BFI)
   - Letters from students



6. Once all the elements are complete, the production team should work with the pieces to lay out the newspaper in the way it will look when printing is complete. If a computer capable of composing pages is available, you may decide to use it to complete this step. If hand produced, students will need to position the elements by cutting and pasting articles and art (preferably black and white) on a page. Begin by drawing the exact dimensions of the newspaper on a piece of paper or tag board that is slightly larger than the dimensions of your newspaper. You will need one of these layout boards for each page of the publication. Place the immobile elements (e.g. banner, page numbers, borders) on the appropriate pages. Decide where everything should go and how best it will all fit. Glue articles and artwork into place. Press down the edges with a roller to be sure the surface is smooth.
7. Investigate printing your newspaper on recycled paper, and devise a method to collect the papers for recycling after they've been read.
8. Determine how many papers you'll print and how they'll be distributed: in the lunch line, classrooms, library, etc.

Newspaper Planning Worksheet

Story	Writer(s)/Art Coordinator(s)	Deadline



Language Activity

Radio Waves Teach Recycling Ways

Objective

Students will learn the messages and methods of recycling by writing and recording radio and/or video commercials for the class or school.

Materials Supplied

None

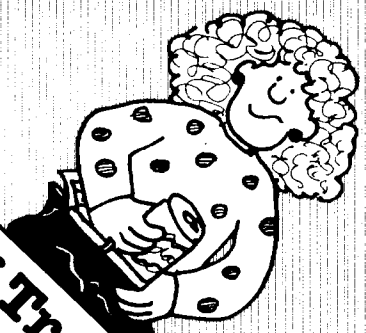
Materials Needed

Paper, pencils, tape recorders, a camcorder, and video and audio cassette tapes

Procedure

1. Divide the class into groups of four or five students each.
2. Explain that each group will write and record a radio or television commercial to teach and promote recycling to their peers.
3. Before creating the commercial, have teams state the message they wish to convey - what will the ad tell people?
4. Explain that students can get their message across in many creative ways: using sound effects and music, multiple voices, impersonations, person-on-the-street interviews, etc.
5. Give students time to discuss what they will do and prepare to record their commercial. They may need some time to gather items that they'll use in recording.
6. Rehearse and record the commercials and present them to the class, to their families, or perhaps to the school.

Chapter Five



Fitting Trash into Your Pocketbook

Summary

Applicable to the core subjects science, mathematics, social studies and language arts

Included are:

- lessons in arithmetic and the metric system as students learn how packaging choices affect the price of certain products
- the opportunity for students to prepare a recycling presentation for their class, school or community

Chapter Objectives

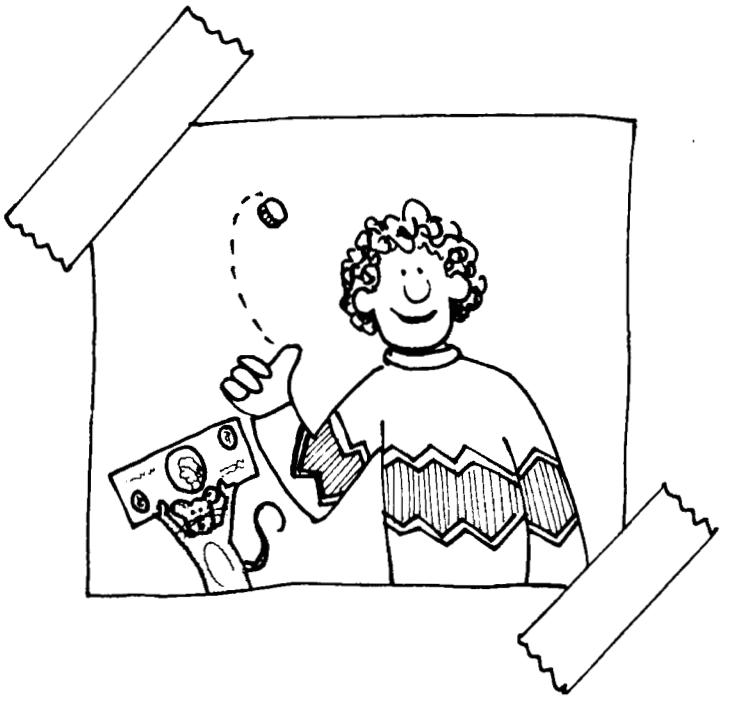
Students will learn how packaging choices affect the price of certain products. They will sharpen arithmetic skills through exercises designed to give meaning to the size and scope of the solid waste disposal issue.

Chapter Outline

I. **Lesson One:** Paying the True Price for Beverages
   A. Procedure
   B. Discussion
II. **Lesson Two:** Math and Logic Problems
   A. Procedure
   B. The MOBIUS Recycling Center
   C. The MOBIUS Beverage Company
III. **Lesson Three:** MOBIUS Masters the Metric System
   A. Procedure
   B. MOBIUS Measures up Recycling
IV. **Answers for Lessons Two and Three**
V. **Activity**
   A. "When I Grow Up I Want to be a Teacher"

Note to teachers:

Where applicable and available, metric information has been included. Not all conversions, however, are provided. Feel free to convert these lessons to the metric system where you see fit. In addition, Lesson Three in this chapter addresses addition, multiplication, weights and measures, and metric conversions.



Chapter Five
Lesson One

Paying the True Price for Beverages

Concepts and Skills Addressed

Self expression
Problem solving

Materials Needed

Liquid containers from home - glass, plastic, metal, paper

Materials Supplied

Discussion Questions

Students will explore the differences between various types of containers. They will see how size affects the cost of the products we buy.

A. Procedure

1. Ask the students to bring in liquid containers from home. You will want to bring some examples yourself to be sure there are many different kinds, including both returnable and nonreturnable glass bottles, a plastic milk bottle, a paper milk carton, a plastic beverage bottle, and an aluminum can. (You will need some examples of 16 oz. glass, plastic and aluminum containers; the exercises are based on size.)
2. Read the message from MOBIUS to the students.
3. Begin the discussion questions by calling on students to identify each different type of container, then go on to the next question.

A Word to Teachers

Be sure to caution students about the type of containers to bring in. Suggest beverage containers and/or those that held food products. Be certain that the students understand they should not bring in containers that held household cleaners, oil, and so on.

A Word to Students from MOBIUS

MOBIUS says: It seems simple. We buy beverages in plastic or nonreturnable bottles and, when we're through with them, we put them in the garbage, and then they are hauled away. But this is not the best thing to do because if we throw them away, they are usually buried in a landfill where they take up a lot of space. Then we have to use more of our natural resources to make more new containers.

There is another choice we can make. We can take our plastic and non-returnable bottles to a recycling center. In many communities, there are recycling centers or buy-back centers that will pay money for the recyclable items. Sometimes, organizations and school groups collect glass, plastic and aluminum containers as part of their fund-raising efforts. In "The Mobius Recycling Center" lesson, you'll find out what these recyclables can be worth.

B. Discussion Questions

What materials are the containers made of?

Glass, plastic, aluminum, paper.

Which of these containers can most easily be recycled?

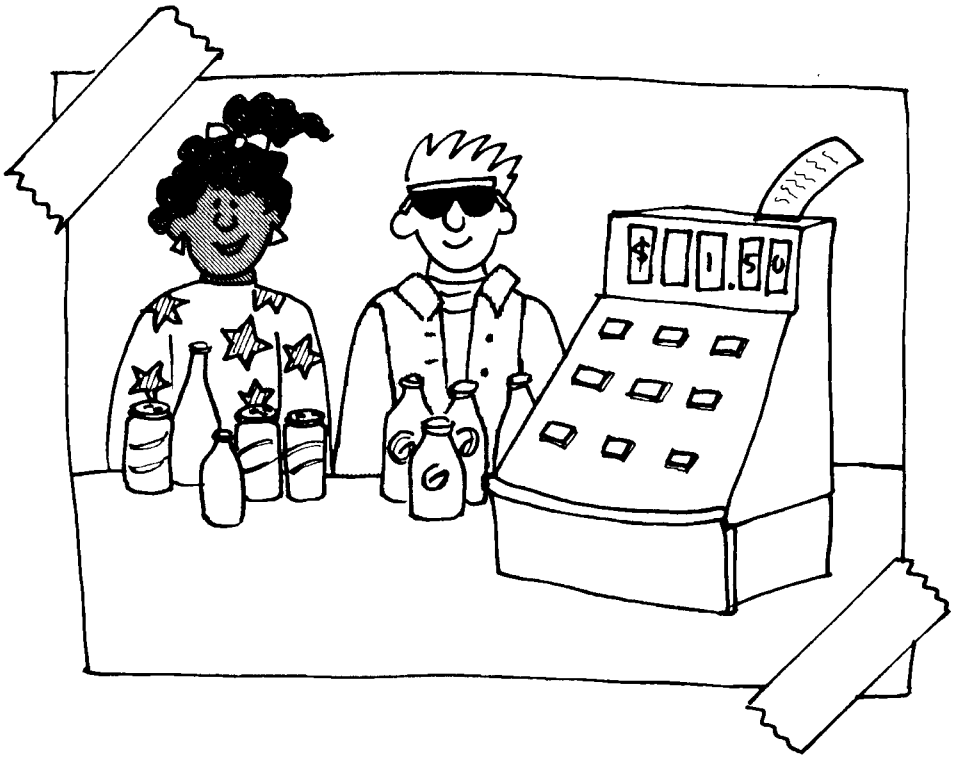
Glass, plastic, aluminum.

What are two ways these containers might be recycled?

1. We can collect them and take them to a recycling center where they will be separated and sold to companies that use them to make new products.
2. We can participate in a neighborhood curbside collection program in which our recyclables are picked up by a waste service company.

Who pays for garbage collection and disposal or curbside recycling? Why?

Cities and individuals pay for garbage collection, disposal, and curbside recycling. Trash removal is a service we pay for either to the city, through taxes, or to a waste services company, through a disposal or recycling fee. It is similar to paying for police protection or for someone to paint our house or to baby-sit.



Chapter Five Lesson Two:

Math and Logic Problems

Concepts and Skills Addressed

Arithmetic

Materials Needed

Paper
Pencil or pen

Materials Supplied

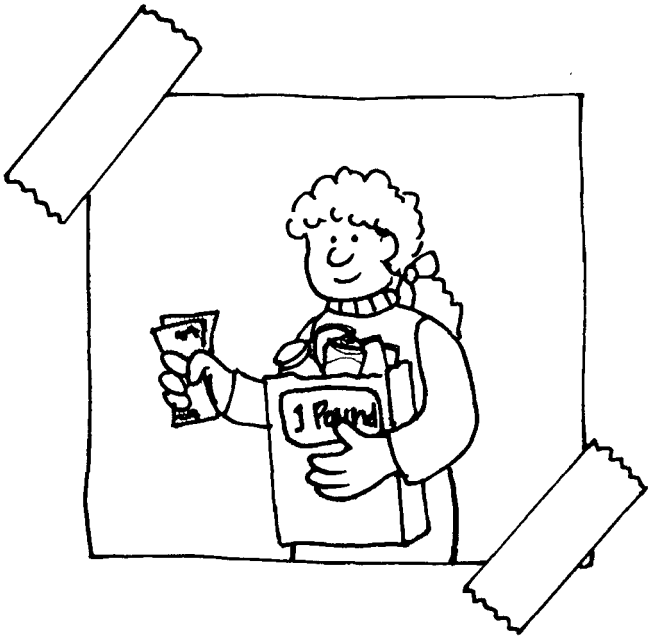
Word Problems

Students will sharpen arithmetic skills while they learn the impact that our choices have on our lives and our environment.

A. Procedure

1. Divide the class into groups of two.
2. Ask students to read each problem aloud and to work out the answer together.
3. Discuss, then hand in the assignment.

B. The MOBIUS Recycling Center



Note to teachers:
Prices in this lesson are based on those in effect at the time of this writing. (Prices for recyclable materials vary according to market demand.)

You have learned that recycling helps us keep useful materials out of the waste stream. But did you know that recycling is a way to earn money? That's right, cans, glass, and plastic bottles can be collected and turned in for money. Imagine that MOBIUS operates a recycling center where you receive money for turning in cans and bottles. Based on the chart, answer the following questions:

Chart One

Material	Value per pound
Glass	2 cents
Plastic	9 cents
Aluminum	45 cents

1. How much money would MOBIUS pay you if you brought him one pound of empty plastic bottles and one pound of aluminum cans?
2. How much money would you earn if you brought MOBIUS one pound of each kind of material?
3. How much money would you earn if you brought MOBIUS two pounds of each material?
4. You collected one pound of aluminum cans and one pound of glass bottles and brought them to the MOBIUS Recycling Center. How much money would you earn? If you stopped at the store on the way home, how much more money would you need to buy a drink that cost $.50?
5. Suppose you knew that you had collected enough glass, plastic bottles, and aluminum cans to earn $10 at the MOBIUS Recycling Center. You plan to spend this money at a carnival. On the way to turn in the recyclables, you run into a friend and invite him or her to come with you to the recycling center and the carnival, but your friend has no money. So you give your pal 11 pounds of aluminum cans so he or she can get some money from MOBIUS. How much money would your friend be able to spend at the carnival? How much money would you get from MOBIUS after you give away the cans?
6. If you collected enough plastic bottles to equal your weight, how much money would they be worth at the MOBIUS Recycling Center? How about aluminum cans? Glass bottles? (**Note:** If you don't know your weight, assume you weigh 80 pounds.)

C. The MOBIUS Beverage Company

Note to teachers: This exercise is designed to show how recycling saves energy in the production process for all types of materials. As late as 1989, U.S. Federal law prohibited the use of recycled plastic in food containers, including those used for beverages. About 1992, however, the Federal Food and Drug Administration approved the use of recycled soft drink bottles when making new bottles. A new chemical process called methanolysis has made this possible. Although it is very expensive, it may someday allow more recycling of plastics into new food containers.

Recycled plastic can be used to make toys, playground equipment and benches, carpet fiber, and in many other non-food applications. Even though the use of recycled plastic in food containers is not as great as the use of recycled glass and aluminum, plastic has been included in this exercise for the sake of consistency and familiarity.

This exercise demonstrates how recycling saves energy in addition to serving as a possible solution to waste disposal problems.

MOBIUS is going to start his own beverage company. He needs your help to figure out how much energy it takes to put his beverages in containers made of glass, aluminum, and plastic. Energy is the amount of power and electricity it takes to make the cans and bottles. It is measured in **Btu**. Once he knows how much energy it takes to make the containers, he can figure out how much to charge for his beverages. Energy costs money; the more energy you save, the more money you save and the lower the price MOBIUS will charge. Of course, he'll want to know how much energy it takes to make containers made of recycled ingredients. And he will compare that to the energy needed to make containers out of ingredients that have not been recycled. MOBIUS hopes to find that by using containers made of recycled ingredients he will save energy and money. He also knows that he would be doing his part to reduce the amount of trash thrown away by creating a need for recycled materials.

Chart Two

Type of container	Btu used per ounce		Btu used per 16 oz. container
Glass			
All recycled ingredients	164	(164 x 16)	2,625
No recycled ingredients	383	(383 x 16)	6,128
Aluminum			
All recycled ingredients	125	(125 x 16)	2,000
No recycled ingredients	391	(391 x 16)	6,250
Plastic			
All recycled ingredients	117	(117 x 16)	1,872
No recycled ingredients	164	(164 x 16)	2,625

If MOBIUS had his way, his beverage company would use only recycled ingredients for each of these containers. To find out how much energy that would take, he decided to see how many Btu it took to make 100 containers in each of the three materials. He simply multiplied the number of Btu per 16 ounce container by 100. Here's what he found:

Chart Three

Type of container	Btu used for 100 containers of all recycled ingredients	Btu used for 100 containers of all new ingredients
Glass	262,500	612,800
Aluminum	200,000	625,000
Plastic	187,200	262,500

Unfortunately for MOBIUS, not everyone recycles all of their containers all of the time. In fact, 25 of every 100 glass bottles, or 25 percent, are recycled, over 63 aluminum cans out of 100 are recycled, and 41 out of every 100 plastic bottles are recycled. Help MOBIUS figure out how many actual Btu are used to make each of these containers based on the above figures and charts.

Glass Equations

1. How many Btu does it take to make 100 glass bottles if 25 of them are made of only recycled materials and the rest are made of no recycled materials?
2. How many Btu would it take if 50 of the bottles were made of all recycled materials and 50 were made of no recycled materials?
3. How many Btu could MOBIUS save for every 100 bottles if people recycled half of their glass bottles, instead of the 25 per 100 they are recycling now? HINT: Subtract your answer to question 2 from your answer to question 1.

Aluminum Equations

1. How many Btu does it take to make 100 aluminum cans if 63 of them are made of recycled materials and the rest are made of all new materials?
2. How many Btu would it take if 85 of the cans were made from all recycled materials and the rest from no recycled materials?
3. Again, how many Btu could MOBIUS save if people recycled 85 percent of their aluminum cans?

Plastic Equations

1. How many Btu does it take to make 100 plastic bottles if 41 of them are made of all recycled materials and the other 59 are made of all new materials?
2. How many Btu would be used if 85 of the bottles, or 85 percent, are made of all recycled materials and the rest are made from all new ingredients?
3. How many Btu would MOBIUS save if this were true?

Chapter Five
Lesson Three

MOBIUS Masters the Metric System

Concepts and Skills Addressed

Addition
Multiplication
Weights and Measures
Metric Conversion

Materials Needed

Paper
Pencil or pen

Materials Supplied

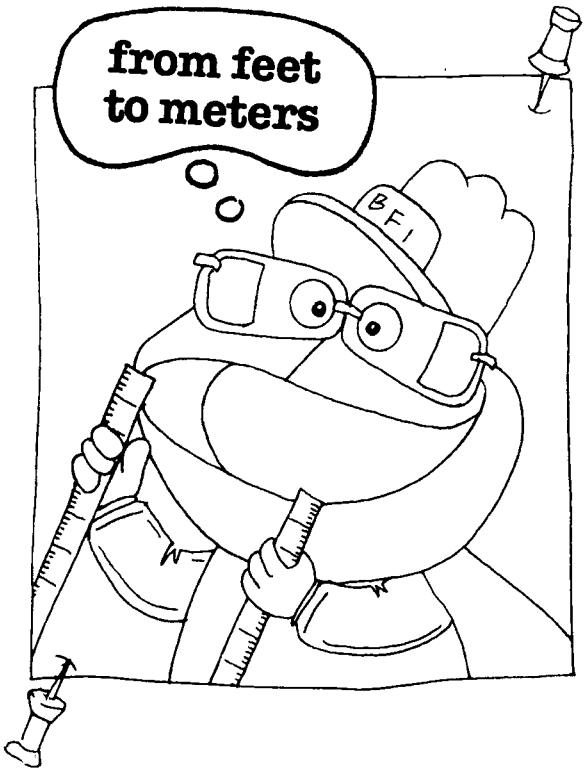
Word Problems
Conversion tables

Students will learn and sharpen mathematical skills in addition, multiplication, and metric conversions while learning the concepts of weights and measures as applied to recycling and waste disposal.

A. Procedure

1. Read the lesson outline and questions on the following pages.
2. Photocopy the lesson for each class member or for pairs or groups of students.
3. Give students time to work through the problems. You may consider assigning each student group certain problems.
4. Work through the answers in class.

B. MOBIUS Measures Up Recycling



There are many different ways to measure things. You may have noticed that all through this book we have put metric measurements after those used in the United States, which uses the U. S. Customary System. MOBIUS loves to learn and he wants to see how these systems work together. Let's take a look.

Metric Measurements

10 grams	=	1 decagram
10 decagrams	=	1 hectogram
10 hectograms	=	1 kilogram
1,000 kilograms	=	1 metric ton
907 kilograms	=	1 short ton

10 meters	=	1 decameter
10 decameters	=	1 hectometer
10 hectometers	=	1 kilometer (or 1,000 meters)

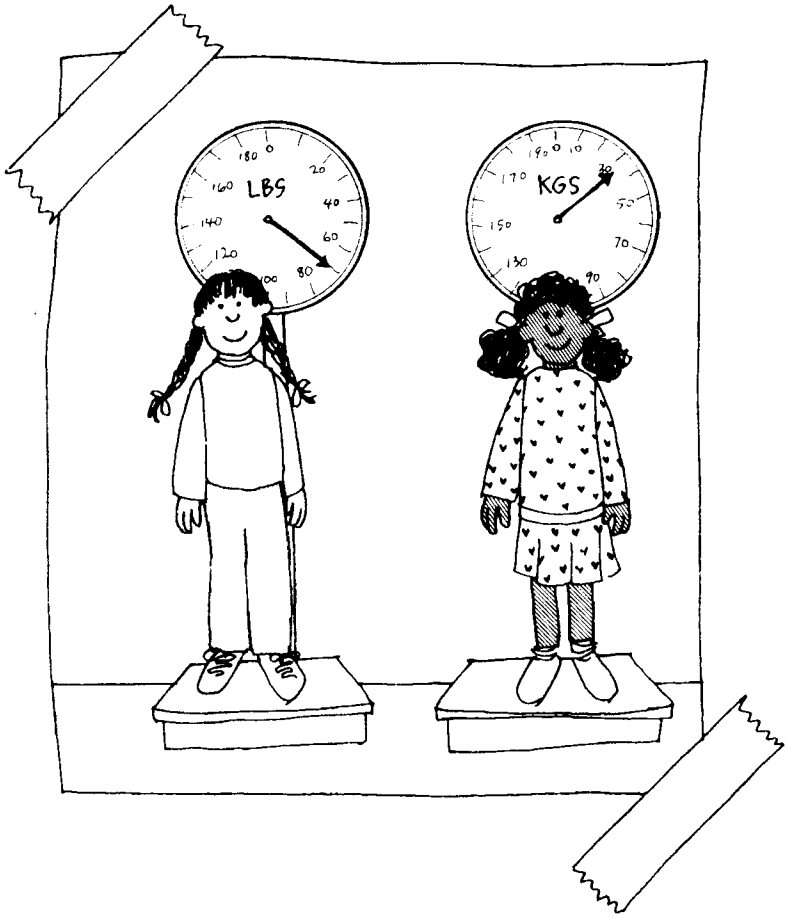
U. S. Customary System

16 ounces	=	1 pound
100 pounds	=	1 hundredweight
2,000 pounds	=	1 ton (also called a short ton)

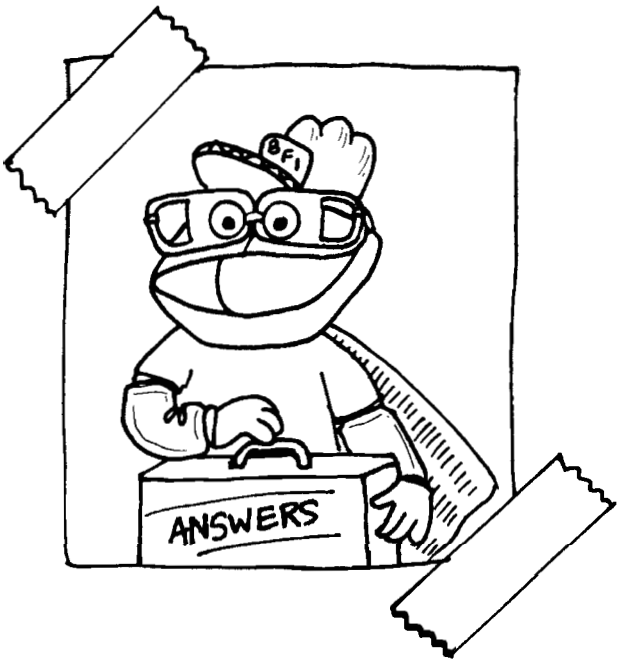
12 inches	=	1 foot
3 feet	=	1 yard
1,760 yards	=	1 mile (5,280 feet)

From	To	Multiply by
Pounds	Kilograms	0.454
Kilograms	Pounds	2.205
Feet	Meters	0.3048
Meters	Feet	3.282
Metric tons	Short tons	1.102
Short tons	Metric tons	.907

1. If we generate or create 4.4 pounds of garbage every day, how many kilograms do we create in a week?
2. If your family recycles 11 kilograms of aluminum cans in a month, how many pounds of cans do you recycle in a year?
3. By recycling one ton of newspapers, you are preserving about 3 cubic yards of landfill space, or a box 3 feet by 3 feet by 9 feet. How much space are you preserving in meters?
4. The MOBIUS Recycling Center is one kilometer from your home. You can only carry ten pounds that far or you'll have to take your bicycle. You have six kilograms of recyclables. How many pounds of recyclables do you have and how will you get to the Recycling Center?
5. What's the fastest way to get to the neighborhood paper drive taking place at your school? Past Michael's house, which totals one kilometer from your house to school, or past Jennifer's, which is a one mile trip from your house to school?
6. How much do you weigh in kilograms? In pounds?
7. In the United States, each person generates 150 pounds of plastic trash per year. How many kilograms of plastic trash does each person produce?
8. Of the 19,300,000 tons of plastic trash generated, 680,000 tons is recycled each year. How many metric tons are generated? How many metric tons are recycled?



Answers for Lessons Two and Three



The MOBIUS Recycling Center

1. 54 cents
2. 56 cents
3. 112 cents
4. 47 cents; 3 cents
5. $4.95; $5.05
6. 80 pounds of plastic is worth $7.20; 80 pounds of aluminum is worth $36.00; and 80 pounds of glass is worth $1.60.

The MOBIUS Beverage Company

Glass Equations

1. 65,625 – 25 recycled bottles (25 x 2,625)
   + 459,600 – 75 bottles of nonrecycled materials (75 x 6,128)

   525,225 – Total Btu

2. 131,250 – (50 x 2,625)
   + 306,400 – (50 x 6,128)

   437,650 – Total Btu

3. **87,575 – Btu saved**

Aluminum Equations

1. 126,000 – (63 x 2,000)
   + 231,250 – (37 x 6,250)

   357,250 – Total Btu

2. 170,000 – (85 x 2,000)
   + 93,750 – (15 x 6,250)

   263,750 – Total Btu

3. **93,500 – Btu saved**

Plastic Equations

1. 76,752 – (41 x 1,872)
   + 154,875 – (59 x 2,625)

   231,627 – Total Btu

2. 159,120 – (85 x 1,872)
   + 39,375 – (15 x 2,625)

   198,495 – Total Btu

3. **33,132 – Btu saved**

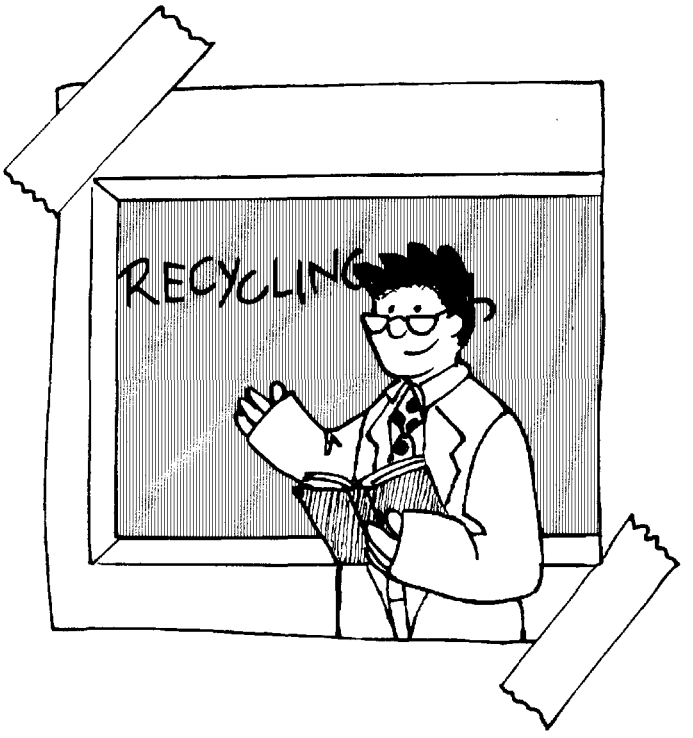
The MOBIUS Metric System

1. 13.98 kilograms of garbage per week
   30.8 – pounds per week (4.4 pounds x 7 days)
   x .454 – pounds to kilograms multiplier
   13.98 – kilograms of garbage per week

2. 291 pounds per year
   132 – kilograms per year (11 kilograms x 12 months)
   x 2.205 – kilograms to pounds multiplier
   291.06 – pounds per year

3. A box .9144 meters (3 feet x 0.3048) by .9144 meters (3 feet x .3048) by 2.7432 meters (9 feet x 0.3048)
4. 13.23 pounds (6 kilograms x 2.205), you'll have to take your bicycle
5. Past Michael's house is faster. There are 3,282 feet in a kilometer (1,000 meters x 3.282), a mile equals 5,280 feet.
6. If you weigh 80 pounds, you weigh 36.32 kilograms (80 x .454 = 36.32). If you weigh 40 kilograms, you weigh 88.2 pounds (40 x 2.205 = 88.2).
7. 68.1 kilograms. (150 pounds x .454)
8. 17,505,100 metric tons generated (19,300,000 tons x .907), 616,760 metric tons recycled (680,000 tons x .907)

Public Speaking/ Drama Activity



"When I Grow up I Want to be a Teacher."

Objective

Students will learn the concepts of recycling by planning presentations or lessons on recycling for younger children in the school.

Materials Supplied

None

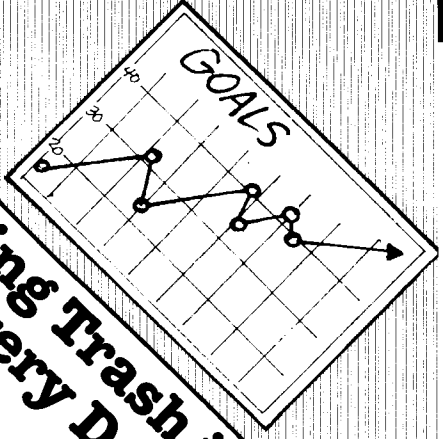
Materials Needed

It's up to you

Procedure

1. Ask teachers in the lower grades whether they would be interested in a presentation on recycling from your class.
2. If reception is good, decide what form your presentation will take. You may want to consult with your class and decide as a group.
3. Some ideas include:
   - Presenting the mini-play "Here Today, Still Here Tomorrow," found in Chapter Two.
   - Planning skits and performing them.
   - Planning a special issue of the newspaper for younger children outlined in the Chapter Four activity.
   - Helping a younger class participate in a recycling project by teaching them the basics of recycling and encouraging them to recycle at home or contribute to a recycling program at school.

Chapter Six



Fitting Trash into Every Day

Summary

Applicable to the core subjects science, mathematics, social studies and language arts

Included is:

- a class activity that integrates all the lessons learned in the Mobius curriculum as students work together to create their own recycling program for their class or entire school.

Note to teachers:

Because this chapter involves active recycling on the part of the school, its success depends on the availability of a recycling center or the arrangement of recycling pickup in your area.

Chapter Objective

Students will explore and demonstrate team building and leadership by coordinating and participating in a classroom recycling project or for a number of classes in the school. They will learn by setting goals and tracking their progress as they go along.

Chapter Outline

Our Environmental Responsibility - Reduce, Reuse, Recycle

I. **Lesson:** Our Environmental Responsibility - Reduce, Reuse, Recycle
   A. Procedure
      1. What do we do?
      2. What do we need?
      3. Who can help us?

Chapter Six
Lesson One

Our Environmental Responsibility – Reduce, Reuse, Recycle

Concepts and Skills Addressed

Leadership
Team work
Communication

Materials Needed

Bins for each participating classroom to collect recyclables
A bulletin board to track the students' progress toward their goal

Materials Supplied

A planning guide for your recycling program

Students will develop a recycling project for their classroom or for a number of classes in the school.

Procedure

Follow the steps outlined throughout the planning guide.

MOBIUS Recycling Planning Guide

1. What do we do?

If your school is not already recycling on a regular basis, here is an opportunity to get started. This could be a big project, even for one classroom, so the best way to start is by planning.

a. Set goals.

Ask the class to set goals for how long they want to run the recycling program. We know that recycling must become a habit for a lifetime, but that can seem like an awfully long time at first. Start with a goal of a week or a month or set a goal based on weight or volume. Gather the recyclable paper discarded in your classroom daily and weigh it. Keep track of the amount saved on a chart so that students can see their progress. (As summarized in Chapter Four, 17 trees are conserved for each ton of paper recycled.) The school cafeteria personnel could become involved if you ask them to save cans and other recyclable containers. Students could also bring in recyclables from home (if recycling is not yet available in your area).

b. Choose a coordinator.

Whether one class is involved or 100, someone has to coordinate the effort. The coordinator could be a responsible student, a teacher, or a task force made up of administrators. If the project turns out to be large, a multi-tiered approach may be needed to better handle the work. While leadership is a key part of making any project work, remember to cultivate good followers along with budding leaders in your class.

c. Set rewards.

Every goal deserves a reward when it is accomplished. If recyclables in your area can be turned in for cash, the group could choose to buy something for the school or their class. Classes may choose to challenge other classes, or you may want to challenge another school in your area to see which school collects the most recyclables within a set period of time. A celebration could be planned at the end for everyone involved. The point is not to spend a lot of money on a party but to recognize the school's accomplishment toward recycling and environmental responsibility.

2. What do we need?

Some supplies are needed, and arrangements must be made to make a school recycling program work. Residents in your area may already recycle at home. If so, your school program will include only the recyclables generated at the school. If not, your program may include bringing recyclables from home.

a. Classrooms need separate collection boxes or containers and a central storage area must be provided to hold the recyclables.

b. Transportation to a recycling center or transfer station will have to be arranged. Perhaps your local recycling company will pick up the materials, or parents and teachers could volunteer to take them there at regular times or at the end of the program.

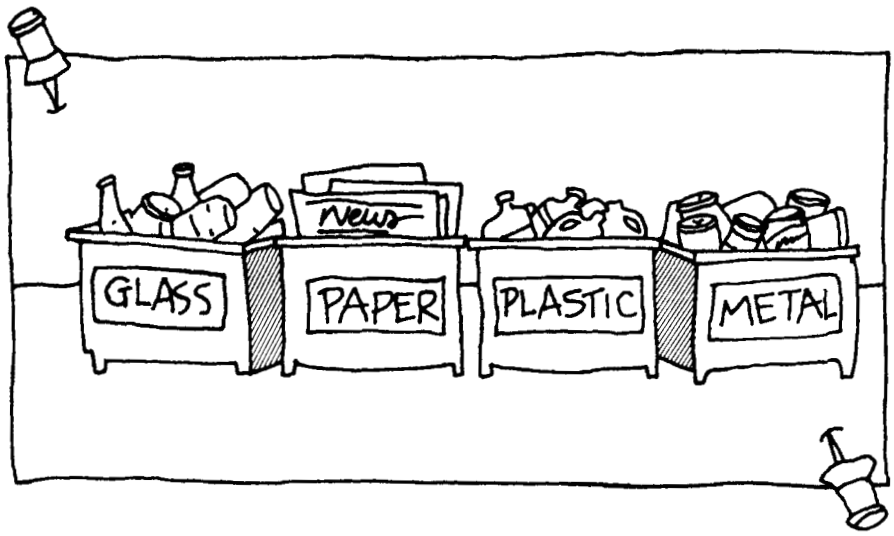
c. If your program is designed as a contest between classes or another school, a means of counting or weighing the material must be arranged.

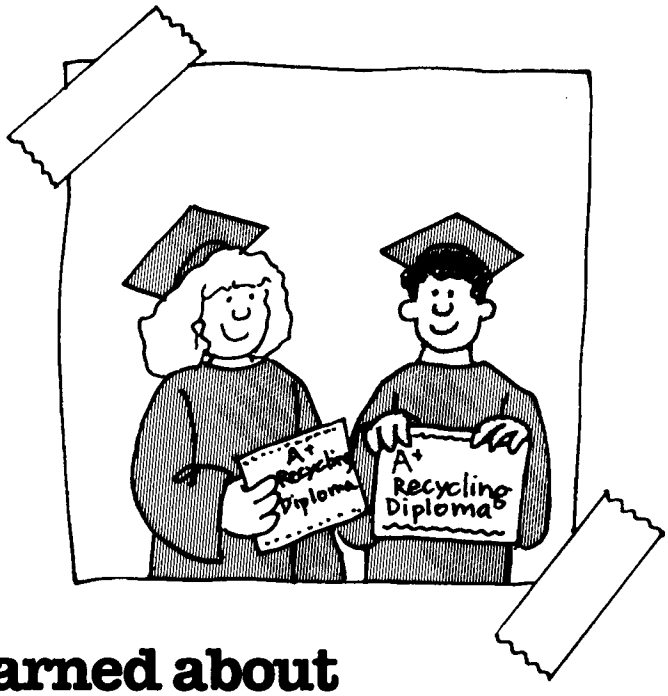
d. A speaker may be brought in to give students an opportunity to ask questions. (If there is a BFI district office in your area, you may call and ask them if they have speakers available.)

e. A tour could be planned of a recycling facility, transfer station, glass or can factory, or sanitary landfill site. (Feel free to call your local BFI district office to inquire about tours of their facilities.)

3. Who can help us?

Call your local BFI district office or other area recycling company. If you don't know anyone in your area that collects recyclables, contact the solid waste hauler for your school and ask them who you should talk to about a class recycling project. Also, most cities have a solid waste department or public works director who can provide information.





MOBIUS Curriculum Post Quiz

How much have you learned about recycling?

Procedure

Administer the quiz found in Chapter One, Lesson One, to students individually or in groups. The quiz can be set up in two ways:

1. If given to students individually, you may elect to give them a block of time to answer all 20 questions and then discuss each answer.
2. If working in groups, you may allow one to two minutes for students to discuss and complete each answer and then discuss the correct answer as a class.
3. We encourage you to begin your recycling unit with the pre-quiz in Chapter One and give the same quiz after you've finished instruction.

   If your class took the pre-quiz at the beginning of your recycling unit, you may elect to hand them out again after taking this quiz and compare their answers.
4. Although this is a post quiz, you are encouraged to use this as an additional learning tool for your students by discussing answers in class.

How much have you learned about recycling? Can you answer these questions?

1. How much **trash** does each person in the United States generate or create daily?

   ___ 1 pound (.45 kilograms)

   ___ 1.5 pounds (.68 kilograms)

   ___ 4.4 pounds (2 kilograms)

   ___ 10.12 pounds (4.6 kilograms)

2. What type of trash do we generate or create more often than any other?

   ___ paper

   ___ glass

   ___ plastic

   ___ aluminum and tin cans

3. If I could change something about the way I recycle, I would

   _____

   _____

4. Many communities have passed laws that encourage recycling.

   ___ True

   ___ False

5. When I recycle at home, I hope to do a better job at

   _____

   _____

   _____

6. Approximately how many **aluminum** cans are thrown away each year rather than recycled?

___ 100,000

___ 34 million

___ 1 billion

___ 30 billion

7. When I think of all the things that can be recycled and are not, I

_____

_____

_____

8. If I see someone throw a recyclable item away, I

_____

_____

_____

9. How much of our discarded trash is packaging (boxes, bags, wrappers)?

___ too little to measure

___ 10 percent of our trash by weight

___ 29.4 percent of our trash by weight

___ almost all of our trash

10. To **recycle** means to process waste materials into new products.

___ True

___ False

11. To **reuse** means to use something again for the same purpose or to find new uses for it in its original form.

___ True

___ False

12. I like recycling because

_____

_____

13. Most of our **garbage** is:

___ Buried (in landfills)

___ Burned (in waste-to-energy plants)

___ Reused

___ Recycled

14. **Open dumps** are the same as **sanitary landfills**.

___ True

___ False

15. Sanitary landfills protect **ground water** by using liners to contain garbage deposited in them.

___ True

___ False

16. **Waste-to-energy** means trash is burned to create energy.

___ True

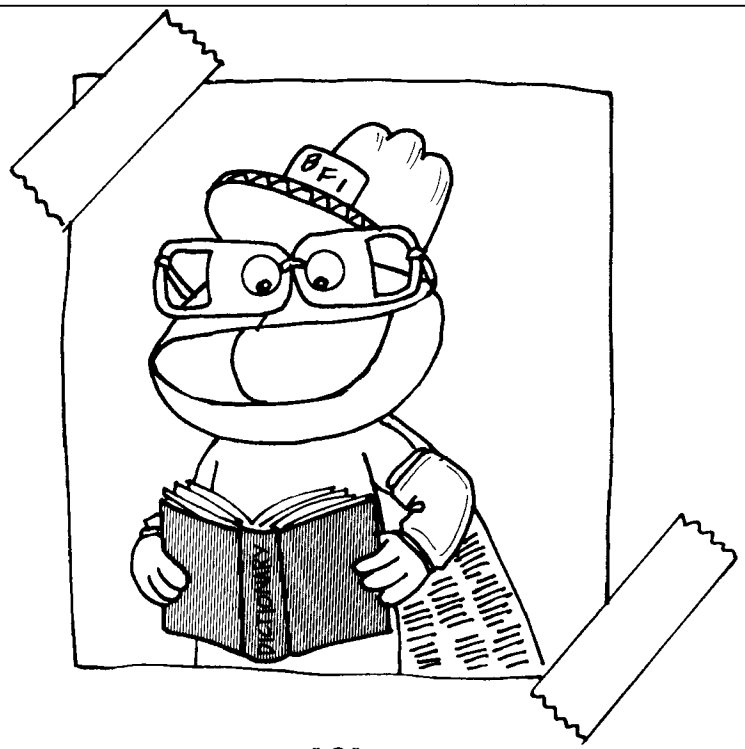
___ False

17. The best thing about recycling is

18. Sometimes recycling is hard because

19. As I grow older, I hope recycling

20. To me, recycling means



Teacher Answer Sheet

1. **About 4.4 pounds (2 kilograms).** According to the latest statistics, every American generates or creates about 4.4 pounds of trash a day. If you take an average of 4.4 pounds of trash per American, per day, how much trash would an average American family of four generate in a week? (4.4 x 4 = 17.6 pounds per day; 17.6 x 7 days a week = 123.2 pounds a week) What does 123 pounds (56 kilograms) of trash look like? How much of it could be reused or recycled?

   NOTE: For the first time, the United States Environmental Protection Agency projects a decrease of per capita generation - to 4.3 pounds by the year 2000. Various source reduction activities are expected to have a positive influence in reducing the waste stream. Increased composting efforts and leaving grass clippings on lawns have resulted in less yard trimmings entering the waste stream. Other factors include the effort to reduce packaging, and increased government regulations that lead to these actions for more than half of the U.S. population. If we all increase our efforts to reduce, reuse and recycle, we can decrease the amount of trash we generate even more.

2. **37.6 percent of our garbage is paper.** Yard waste (leaves, grass clippings) makes up 15.9 percent; food waste, 6.7 percent; glass, 6.6 percent; metal, 8.3 percent; plastic, 9.3 percent; the remaining 15.6 percent is a combination of other materials like textiles, rubber, wood, and rubble.

3. Ask students to read their answers and discuss.

4. **True.** By 1995, all states had passed some type of recycling legislation. These laws provide a framework for statewide recycling efforts and, in some cases, require local governments and citizens to participate in collection efforts. There has been a big change since 1989-90. At that time, there were approximately 1,000 curbside recycling programs in operation in communities around the country. By 1995, there were more than 6500.

5. Ask students to read their answers and discuss.

6. **30 billion aluminum cans are thrown away, rather than recycled, each year in the United States.** Other statistics: 2.97 million tons (2.7 million metric tons) of tires are thrown out; 51.4 million tons (46.6 million metric tons) of paper; 10.7 million tons (9.7 million metric tons) of glass; and 18.6 million tons (16.9 million metric tons) of plastic are discarded every year.

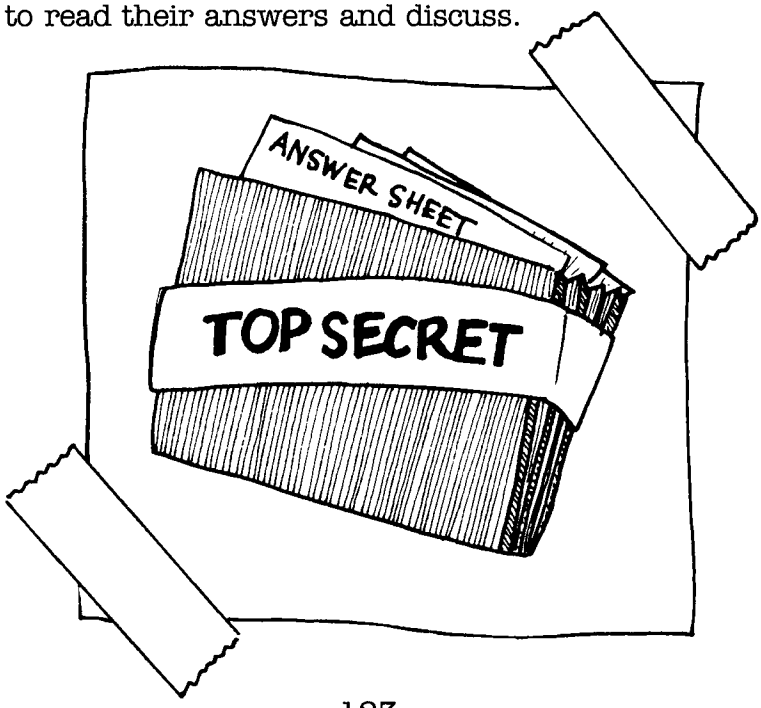
7. Ask students to read their answers and discuss.

8. Ask students to read their answers and discuss.

9. **29.4 percent by weight and 32.1 percent by volume of discarded waste is packaging.** This means a large percentage of what we buy is packaging that in most cases is disposed of immediately.

10. **True.** An example of recycling is turning newspaper into egg cartons. Recycled glass bottles and jars are melted down to make brand new bottles and jars. Recycling is different from reusing.

11. **True.** To reuse means to use something again for the same or a different purpose than the item's original form. For example, when we return our empty bottles to the store and they are cleaned and used again or when we use the back of a sheet of paper for notes or to find the answer to math problems, instead of using a new sheet.
12. Ask students to read their answers and discuss.
13. **62.4 percent of our garbage is buried in landfills (a reduction of about 10 percent from 1989);** approximately 15 percent is burned in waste-to-energy plants to produce energy; 18.6 percent is recycled and 3 percent is composted.
14. **False.** Open dumps contain waste that is allowed to remain exposed to the atmosphere over long periods of time. Open dumps are being phased out in the United States. Sanitary landfills are different. They contain a specially designed liner that protects the environment by keeping the waste sealed within the ground. Heavy machinery covers the waste daily with six inches of soil or a special fabric cover. Today there are approximately 6,000 sanitary landfills in the United States that can accept household trash. However, developing new landfills is difficult because land that is suitable is hard to find near cities and towns, where a majority of our waste is created. More and more waste is being generated, but fewer and fewer places are being found to put it all.
15. **True.** The liners used in sanitary landfills protect ground water by preventing leachate (see glossary) from seeping into the water supply.
16. **True.** Waste-to-energy plants reduce waste volume by converting waste into heat energy and a small amount of ash. Waste-to-energy is a reliable source of waste disposal.
17. Ask students to read their answers and discuss.
18. Ask students to read their answers and discuss.
19. Ask students to read their answers and discuss.
20. Ask students to read their answers and discuss.



Glossary of Terms

aluminum A strong, light, silver-colored metal made mostly from bauxite ore.
ashfill A specially constructed landfill to be used only for disposing of ash from waste-to-energy plants.
asphalt A dark, tar-like material made from petroleum and gravel that is used to pave roadways.
bacteria Single-celled living organisms that can cause disease; they also can break down solid waste.
bauxite A mineral. Most of the aluminum in the world can be found in bauxite.
biodegradable Material that is able to be broken down by microorganisms; includes most organic wastes.
Btu British Thermal Unit. A measurement of the amount of heat needed to raise the temperature of one pound of water by one degree Celsius.
carbon dioxide (CO_2) A colorless, odorless, noncombustible gas made of carbon and oxygen molecules, which animals exhale when they breathe. Plants use this chemical in photosynthesis.
cell The area in a landfill where several layers of solid waste are deposited each day. At the end of the day, the layers are covered with soil and a cell is formed. Cells are built side by side and on top of one another until the landfill is completely filled.
combustible Capable of igniting or burning.
commercial solid waste The waste from businesses.
compost Decayed, organic waste that can be used for fertilizer. Composting is the process of collecting and producing compost.
contaminate To make impure or not clean.
cullet Scrap glass that has been broken into tiny pieces.
curbside recycling program The process of separating recyclables to be picked up by a recycling truck at our homes. Many cities and communities now have curbside recycling programs.
cycle A continuous process.
decay The breakdown of materials, chiefly by bacteria.
decompose To break down, change form.
degradable Capable of decomposing.
environment The elements around us that influence our health, like the air we breathe and the water we drink.
environmental cycle A regularly recurring chain of natural events that happens all around us every day. For example, a tree grows up and drops seeds that become new trees.
Environmental Protection Agency (EPA) The federal government office in charge of making sure that our environment is safe to live in.
environmentally sound A product, practice or thing that does not harm or disturb the environment.
feldspar A mineral found in many different rocks. It is one of the many materials used to make glass.
fiberglass Small pieces of glass that are made into yarn. The yarn is woven into a fabric that is used in insulation and molded as a plastic.
garbage Wastes, like food, that are likely to decompose.
glass A transparent, inorganic material produced by melting almost pure silica sand with burnt lime or limestone and soda ash, which gives hardness and chemical durability.
glassphalt A paving material that is very similar to asphalt. It is made of petroleum and cullet, rather than petroleum and gravel.
grades (Not the ones in school.) A term used to label different quality-types of the same material. For example, newspaper is a different grade of paper than stationery paper. Each grade is recycled separately.
ground water Water in the earth that supplies wells and springs. In many places, wells and springs are used for drinking water.
hazardous waste Waste that can harm the environment because of its chemical makeup.

household hazardous wastes Wastes found around the house that can harm people or the environment because of their chemical makeup. Examples of household hazardous wastes include paint and paint cans, chemicals, medicines, and inorganic cleaning supplies. Because of their hazardous nature, they should be stored properly and disposed of separately from the rest of household trash.

humus A rich, natural, soil-like fertilizer that is the result of composting.

hydrogen sulfide (H_2S) A flammable, poisonous gas, made of hydrogen and sulfur molecules, which smells like rotten eggs.

impermeable The characteristic that greatly slows or restricts the ability of a liquid to spread or flow through. Something that is impermeable will not absorb water, for example.

incineration The process of burning something to ashes.

incinerator A building where garbage and other waste materials are burned to create a smaller amount of solid waste in the form of ash.

industrial Having to do with industries.

industrial solid waste The waste from industries.

inorganic Things that are not made from plants and animals, and do not contain the element carbon. For example, chlorine used in pools and ammonia cleaners. (see organic)

leachate Liquid, including rain water, that has passed through or comes from solid waste. This liquid collects at the bottom of a landfill. In sanitary landfills, leachate is collected and cleaned, usually by sending it through the local sewage treatment plant, then it is returned to lakes, streams, and so on.

lime This powdery material is used to help keep the various ingredients used in papermaking together. It is not to be confused with the green citrus fruit.

limestone A rock made from many different minerals. It is used to make glass.

methanolysis A chemical process to recycle plastic soft drink bottles into a resin that can be used to make new bottles.

methane (CH_4) A highly combustible gas with no smell or color. Methane is produced by solid waste as it decomposes.

microorganism Microscopic living things involved in the composting of wastes and in sewage treatment processes.

mineral An inorganic substance found in nature. Gold, silver, and iron ore are minerals.

mining waste The leftovers from the mining of various minerals. These leftovers usually have no use.

MOBIUS When used in association with the BFI MOBIUS Curriculum, the term refers to the mascot.

Mobius, Augustus F. A German mathematician who lived from 1790-1868. He invented the idea of a continuous strip, or loop, with a single twist in it. The recycling industry uses Mr. Mobius' strip as the familiar recycling arrows.

monofill Another term for an ashfill.

municipal solid waste Includes wastes such as durable goods, nondurable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes from residential, commercial, institutional and industrial sources.

open dump An open disposal site. In the United States, open dumps are being phased out by the Environmental Protection Agency (EPA).

ore Mineral or combination of minerals from which metals or other valuable substances can be mined.

organic Made from living organisms such as plants and animals. Organic substances include tree leaves, wool from sheep, and any other materials containing the nonmetallic element carbon (like diamonds and graphite, which are pure carbon in different forms).

petroleum coke A product made from coal that is used to build fires in furnaces and for making aluminum and steel.

photosynthesis The process by which green plants convert sunlight and minerals contained in the soil into oxygen that we breathe.

pollution The contamination of soil, water, and/or air from the discharge of waste, gases, or chemicals.

precipitation A weather term meaning the deposit or fall, of rain, sleet, or snow.
purification To make something clean and pure.
recyclables Almost all natural and some man-made materials, most commonly glass, aluminum, newspaper, cardboard, tin, plastic, and oil.
recycle To make new products out of used materials like beverage containers, newspapers, and glass.
Recyclery® A BFI recycling center where recycled things are sorted by what they are made of and packaged for shipping. For example, clear glass goes in one area while green glass goes in another.
red mud The material that remains after aluminum has been removed from bauxite ore.
reduce To cut down on the amount of trash we produce.
resin A natural, organic substance used to manufacture varnish, ink, and plastic.
resource recovery A term used to describe waste that is recovered through recycling, waste-to-energy and composting.
reuse To use a product again, either for what it was originally made for or for something else. For example a returnable beverage bottle may be returned and refilled with the soft drink (used for its intended purpose), or it could be used as a flower vase.
salt cake A white powdery material used to make pulp.
sanitary landfill The modern, engineered way to deposit waste into the ground and still protect the environment by adding liners, compacting and covering the waste every day with soil or a special fabric cover, testing ground water, and keeping out hazardous waste.
sewage Liquid or solid waste which is carried off by sewers and purified in a sewage treatment plant.
soda ash A white material made from the mineral called sodium. Soda ash is used to make glass.
soil The upper layer of earth which may be dug.
solid waste Trash and garbage.
solid waste management The ways we get rid of our garbage, including putting it in a landfill, burning it in waste-to-energy plants, recycling it, or composting it. Companies like Browning-Ferris Industries are in the solid waste management business.
solid waste stream or waste stream The cycle that solid waste goes through, from the creation of garbage and trash, to depositing waste in landfills and waste-to-energy plants. The waste stream also includes the recycling process and composting.
source separation To separate recyclables and nonrecyclables at the place where the trash is created. Some curbside recycling programs require source separation.
sump The lowest area of a landfill into which leachate drains before being pumped out and treated at the landfill or at a sewage treatment plant.
tipping fee The price individuals, communities, and trash hauling companies must pay a sanitary landfill operation to get rid of their trash or the trash they collect. The fee is called a tipping fee because truck drivers must unload by tipping up the back of the truck.
topsoil The top layer of soil containing valuable nutrients.
trash Material to be thrown away. Solid waste.
vegetation Plants, trees, shrubs, grass, and the like.
waste stream See solid waste stream.
waste-to-energy plant A facility where energy, in the form of steam or electricity, is produced by burning solid waste, gases, or chemicals.
wood fiber A stringy substance made from wood. This substance makes paper feel the way it does (this is called texture). It also helps keep together the ingredients that make paper.
wood pulp When wood fibers are combined, they are called pulp. The pulp is used to make paper and paperboard.
yard waste Leaves, grass clippings, and other organic materials collected from lawns. Yard waste is used for compost materials.

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United States Environmental Protection Agency. Office of Solid Waste Management. *Characterization of Municipal Solid Waste in the United States: 1994 Update.* Washington, D.C.: U. S. Environmental Protection Agengy.

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World Book Encyclopedia, 1992 ed. S.v. "Metric system."

Browning-Ferris Industries wishes to thank Franklin Associates, Ltd., for their invaluable assistance in updating many of the statistics concerning municipal solid waste generation, recovery and discards, included in the third edition of the MOBIUS Curriculum.

Resources

Browning-Ferris Industries
Mary Magner, Research Librarian
757 N. Eldridge
Houston, TX 77079
MOBIUS HOTLINE 1-800-BFI-8100
BFI's corporate library staff is available to provide research assistance to teachers who would like additional information on recycling and solid waste issues. Personal appearances for Mobius, the program's mascot, may be arranged through your local BFI District Office.

The Aluminum Association
900 19th St. N. W., Suite 300
Washington, D.C. 20006
(202) 862-5100
The Aluminum Association has a video tape available entitled Recycling: Your Next Assignment. It is a well organized, 18 minute show, with good, clear information. The video is available to purchase for $35, or may be taken out on loan.

Air and Waste Management Association
1 Gateway Center, Third Floor
Pittsburgh, PA 15222
(412) 232-3444

Council on Packaging in the Environment
1255 23rd St. N.W., Suite 850
Washington, D.C. 20037
(202) 331-0099

The Ecology Center
2530 San Pablo Ave.
Berkeley, CA 94702
(510) 548-2220
Conducts educational and informational recycling programs for newspapers, glass, and metal containers. Maintains a library, bookstore, and information service dealing with such subjects as insect control, recycling, legislation and environmental groups.

Environmental Defense Fund
257 Park Avenue S.
New York, NY 10010
(212) 505-2100
EDF is known for its analysis and sponsorship of novel solutions to environmental problems. Its support for market-based principles to combat acid rain became the centerpiece for the Bush administration's clean air package.

Environmental Industry Associations
4301 Connecticut Ave., N.W., Suite 300
Washington, D.C. 20008
(202) 244-4700
This is the trade association for the waste services industry. It conducts statistical research which is provided to their members.

Friends of the Earth
1025 Vermont Ave. N.W., Suite 300
Washington, D.C. 20005
(202) 783-7400
In January, 1989, FOE merged with the Environmental Policy Institute. The new organization focuses on domestic environmental policy issues and lobbies before Congress and state governments. It issues publications to further its policy goals.

Glass Packaging Institute
1627 K St., N.W., Suite 800
Washington, D.C. 20006
(202) 887-4850
The Glass Packaging Institute publishes *How to Curb the Solid Waste Crisis, Comprehensive Curbside Recycling, and Glass Recycling: Why? How?*

Izaak Walton League
707 Conservation Lane
Gaithersburg, MD 20878-2983
(301) 548-0150
The Izaak Walton League focuses on public education promoting responsible use of the forest and other natural resources. It produces several publications on a regular basis and sponsors a weekly television program, Make Peace With Nature.

Keep America Beautiful (KAB)

Mill River Plaza
Nine W. Broad St.
Stamford, CT 06902
(203) 323-8987

KAB began a continuing advertising campaign against littering in the late 60s and 70s, which is still going on. The organization has expanded greatly and now publishes program manuals, guides, recycling manuals, transcripts, and instructional materials.

Municipal Waste Management Association

1620 I St. N. W., 4th Floor
Washington, D.C. 20006
(202) 293-7330

This is the association for the waste incineration industry. It does not have teaching materials available at this printing, but can provide resources where such materials may be found, and may be able to provide further information on the design and operation of environmentally safe waste recovery facilities.

National Audubon Society

700 Broadway
New York, NY 10003
(212) 979-3000

Main interests are ecology, energy, and the conservation and restoration of natural resources, wildlife habitats, soil, water, and forests. The organization was formed in 1905 out of a protest movement by women seeking to stop the slaughter of Florida wading birds, whose plumes were used to decorate hats. The Audubon Society produces educational materials for school children.

National Parks and Conservation Association

1776 Massachusetts Ave. N. W., Suite 200
Washington, D.C. 20036
(202) 223-6722

Focus is on preservation and promotion of national parks. The educational and scientific organization maintains a 3,000-volume library and publishes a bimonthly magazine.

National Recycling Coalition

1727 Kings St., Suite 105
Alexandria, VA 22314-2720
(703) 683-9025

Supplies further references for recycling and waste handling associations nationwide, including teaching materials and up-to-date resources available.

National Wildlife Federation

1400 16th Street, N.W.
Washington, D.C. 20036
(202) 797-6800

The Wildlife Federation advocates intelligent management of life-sustaining resources, such as protecting wildlife habitats. It also lobbies government on a wide range of issues. The group publishes Nature Scope, a curriculum guide to resource conservation, and sponsors Ranger Rick's Nature Club, as well as daily and weekly radio programs.

Natural Resources Defense Council

40 West 20th Street
New York, NY 10011
(212) 727-2700

The Council is comprised of lawyers, scientists, public health specialists, and transportation, energy, land use, and economic planners. Areas of concern include land use, air and water pollution, toxic substances, and protection of wilderness and wildlife. The Council publishes a number of pamphlets, brochures, books, and reports. It also has a toxic substances information line: 1-800-648-NRDC

Nature Conservancy

1815 N. Lynn Street
Arlington, VA 22209
(703) 841-5300

The Conservancy's mission is to preserve ecological diversity through the protection, acquisition, and stewardship of natural areas. It makes those areas available for nondestructive use on request by most educational and scientific organizations.

Sierra Club

730 Polk Street
San Francisco CA 94109
(415) 776-2211

Through scientific and educational studies, the Club works on the problems of wilderness, forestry, clean air, and energy conservation. In addition to an Environmental Education committee, the Club maintains a 5,000 volume library on environmental topics and publishes several books and magazines.

Society of the Plastics Industry, Inc.

1275 K Street, N.W., Suite 400
Washington, D.C. 20005
(202) 371-5200

The mission of The Society of the Plastics Industry, Inc. (SPI) is to promote the development of the plastics industry and enhance public understanding of its contributions while meeting the needs of society. SPI provides responsible leadership to ensure long-term industry growth and vitality.

Solid America

1100 Wayne Ave., Suite 700
Silver Spring, MD 20910
(301) 585-2898

Goal is to improve solid waste management services to the public through education, training, technical assistance, technology transfer. Maintains a library of 6,000 documents on solid and hazardous waste.

Solid Waste Association of North America

P.O. Box 7219
1100 Wayne Ave., Suite 700
Silver Spring, MD 20910
(301) 585-2898

A non-profit education organization. SWANA's mission is to advance the practice of environmentally and economically sound municipal solid waste management in North America.

Steel Recycling Institute

Foster Plaza X
680 Andersen Dr.
Pittsburgh, PA 15220-2700
(800) 876-7274 or (412) 922-2772

A variety of teaching materials are available through this organization. Steel Cycles: a supplemental environmental education program for grades preK through 12. Each of the program's elements provide ready-to-use materials for teachers, utilizing hands-on activities and experiences for teaching.

Nature's for ME:
a pre-school program designed by Head Start parents and teachers, which provides a broad range of environmental activities to initiate young people into the world of nature and conservation.

YES I CAN!:
a primary school video tape and teacher's guide that offers a charming story while providing information on multi-material recycling.

Order forms and prices are available from the Steel Recycling Institute (SRI). In addition, activity sheets are available for a variety of grade levels and are available free of charge to schools and communities. The SRI has also sponsored an annual scholarship program in selected states for several years.

Wilderness Society

900 17th St. N.W.
Washington, D.C. 20006-2596
(202) 833-2300

Focuses exclusively on protecting the nation's public lands. The Society lobbies to expand wilderness areas and ensure biological diversity. Programs include grass roots organizing, lobbying, research, and public education. Issues an annual report and monthly magazine, as well as notices and alerts on critical issues.

Reading

Adult Literature

The Biocycle Guide to the Art & Science of Composting. Emmaus, Pennsylvania: J.G. Press, 1991.

The Biocycle Guide to Maximum Recycling. Emmaus, Pennsylvania:J.G. Press, 1993.

Brackett, Karen and Manley, Rosie. Beautiful Junk II: *More Creative Classroom Uses for Recyclable Materials.* Carthage, Illinois: Fearon Teacher Aids, 1993.

Lund, Herbert F. *The McGraw Hill Recycling Handbook.* New York, NY: McGraw Hill, 1993.

Patrick, Ken L. *Paper Recycling: Strategies, Economics and Technology.* San Francisco, California: Miller Freeman Publications, 1991.

Platt, Brenda. *Beyond 40 Percent Record Setting: Recycling and Composting Programs.* Washington, DC: Island Press, 1991.

Juvenile Literature

Amos, Janine. *Waste and Recycling,* First Starts Series. Austin, Texas: Raintree Steck-Vaughn Publishers, 1993.

Condon, Judith. *Recycling Glass,* Waste Control Series. New York: Franklin Watts Inc, 1991.

Condon, Judith. *Recycling Paper,* Waste Control Series. New York: Franklin Watts, 1991.

Foster, Joanna. *Cartons, Cans, and Orange Peels: Where Does Your Garbage Go?* New York: Clarion Books, 1991.

Hadingham, Evan and Janet. *Garbage! Where It Comes From, Where It Goes.* A NOVABOOK. New York: Simon and Schuster Inc., 1990.

Hare, Tony. *Recycling,* World About Us Series New York: Gloucester Press, 1991.

Kalbacken, Joan and Lepthien, Emilie U. *Recycling: A New True Book.* Chicago: Childrens Press, 1991.

Palmer, Joy. *Recycling Metal*, Waste Control Series. New York: Franklin Watts, 1990.

Seltzer, Meyer. *Here Comes the Recycling Truck!* Morton Grove, Illinois: Albert Whitman & Company, 1992.

Stefoff, Rebecca. *Recycling,* Earth At Risk Series. New York: Chelsea House Publishers, 1991.

Stwertka, Eve and Albert. *Cleaning Up. How Trash Becomes Treasure,* At Home With Science Series. New York: Julian Messner, 1993.

Wilkes, Angela. *My First Green Book.* New York: Alfred A. Knopf, 1991.

Videos

Recycling, The Earth At Risk Environmental Video Series. Bala Cynwyd, PA: Schlessinger Video Productions, 1993.

Recycling: It's Everybody's Job, National Geographic Society Educational Video Presentations. Washington, D.C.: National Geographic Society, 1992.

Reducing, Reusing and Recycling: Environmental Concerns. Bohemia, NY: Rainbow Educational Video, 1990.

Your local library may have other resources. Begin your search by looking under these subject headings in the card catalog: Recycling (Waste), Refuse and refuse disposal, and Conservation of natural resources.

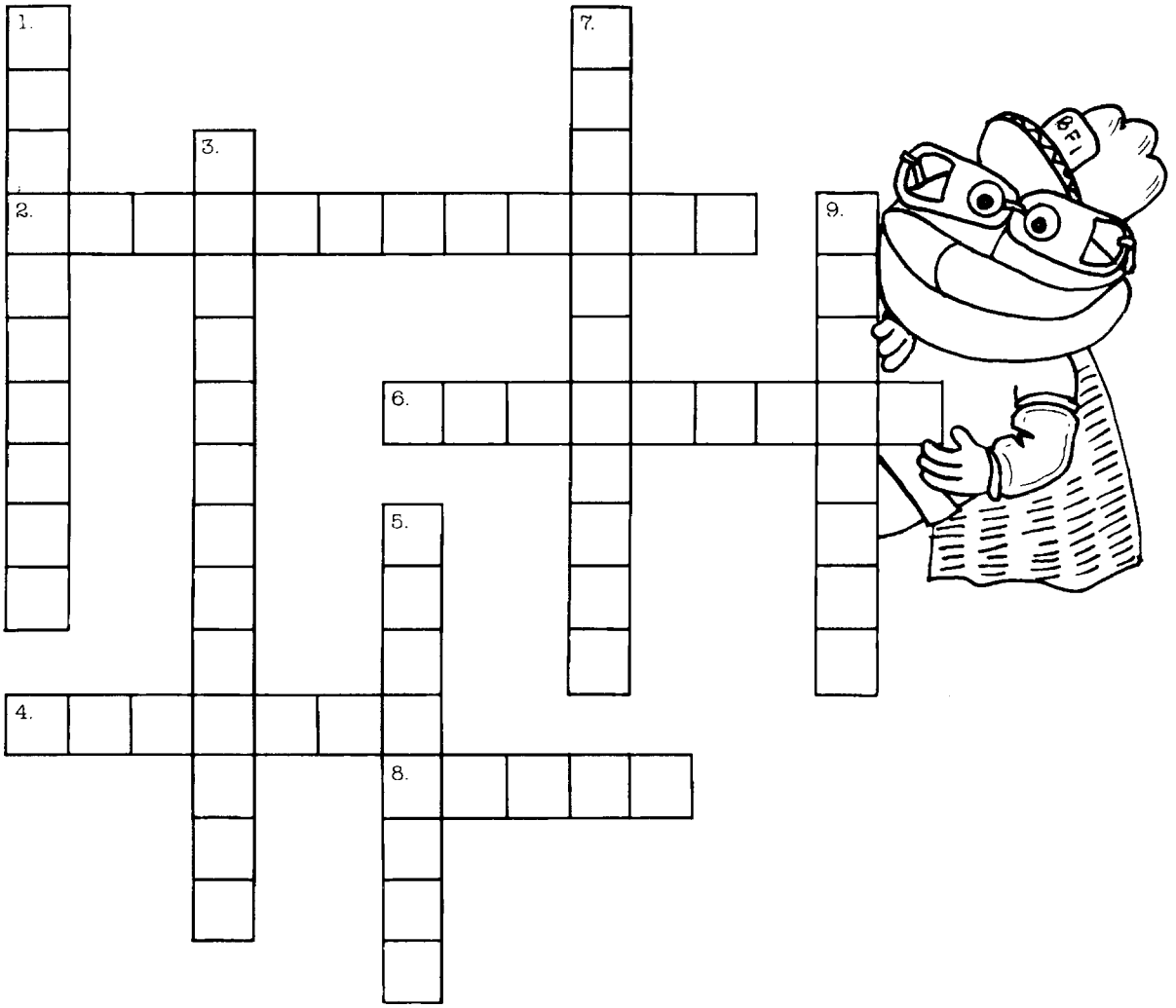
Crossword Puzzle

Across

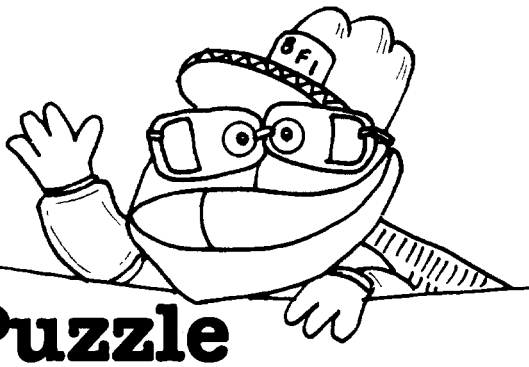
2. To get rid of dirt and pollution.
4. Anything made from living organisms.
6. Things that aren't made from plants and animals.
8. A fertilizer that is the result of composting.

Down

1. Collecting leaves and grass to make into humus.
3. Material that can be broken down by microorganisms.
5. Liquid that passes through solid waste and collects at the bottom of a landfill.
7. Where waste materials are burned.
9. The degree to which solid waste and ash are harmful.



Answers: 1. composting, 2. purification, 3. biodegradable, 4. organic, 5. leachate, 6. inorganic, 7. incinerator, 8. humus, 9. toxicity



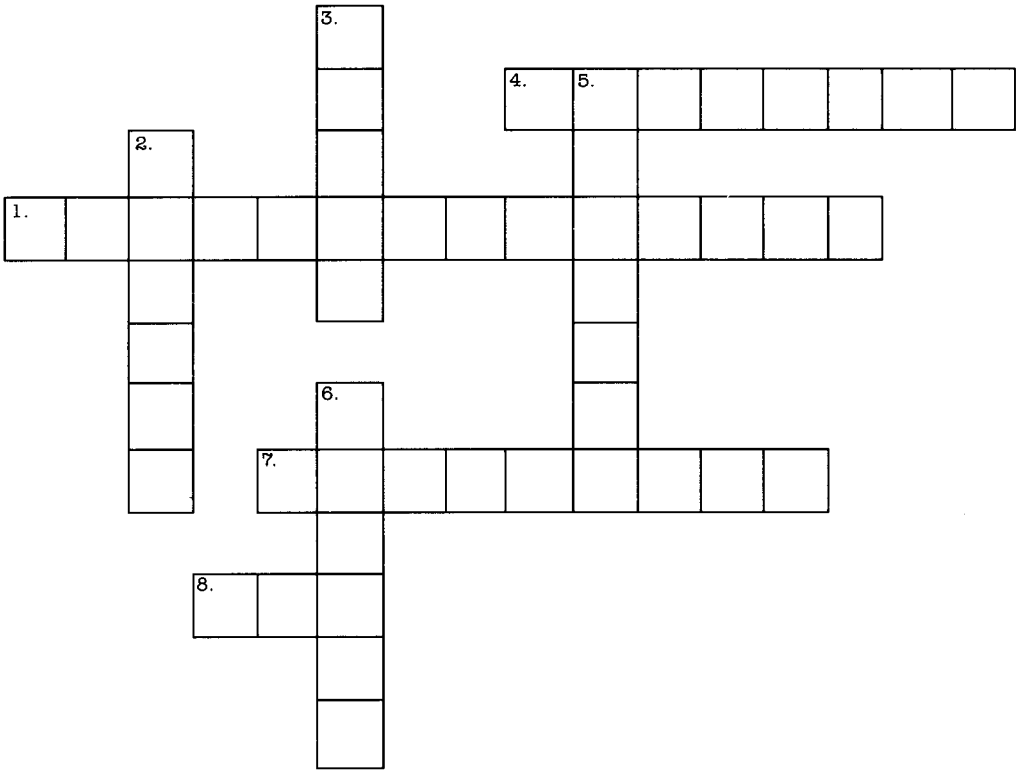
Crossword Puzzle

Across

1. The process by which plants convert sunlight and minerals into oxygen.
4. An environmentally safe place to bury waste.
7. A BFI recycling center.
8. The abbreviation for British Thermal Unit.

Down

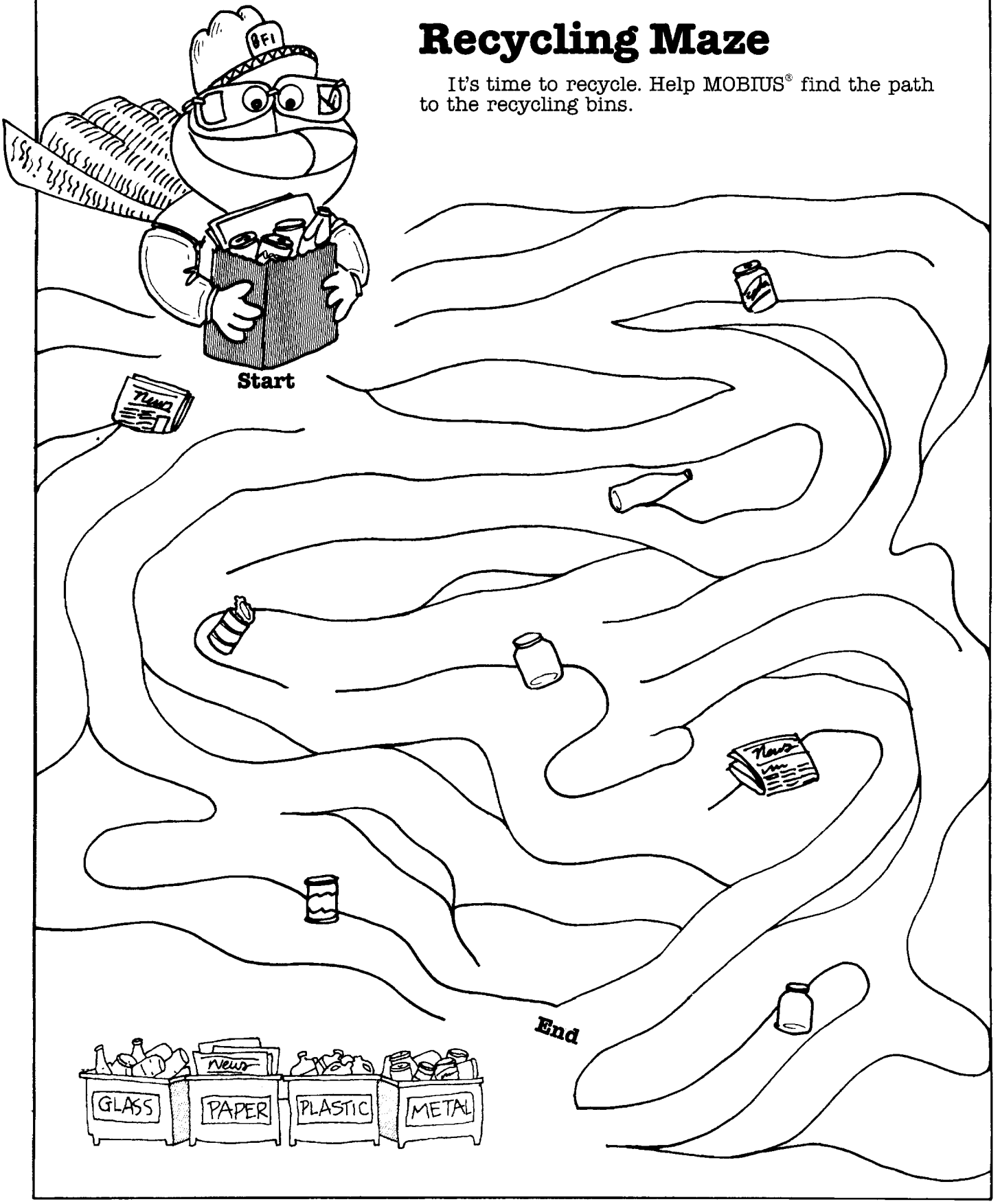
2. The German mathematician who invented the single-sided, continuous loop.
3. To use a product again in its original form.
5. A landfill for the waste from incinerators.
6. To cut down on the amount of trash people generate.



Answers: 1. photosynthesis, 2. Mobius, 3. reuse, 4. landfill
5. ashfill, 6. reduce, 7. Recyclery,™ 8. Btu

Recycling Maze

It's time to recycle. Help MOBIUS® find the path to the recycling bins.



Secret Coded Message

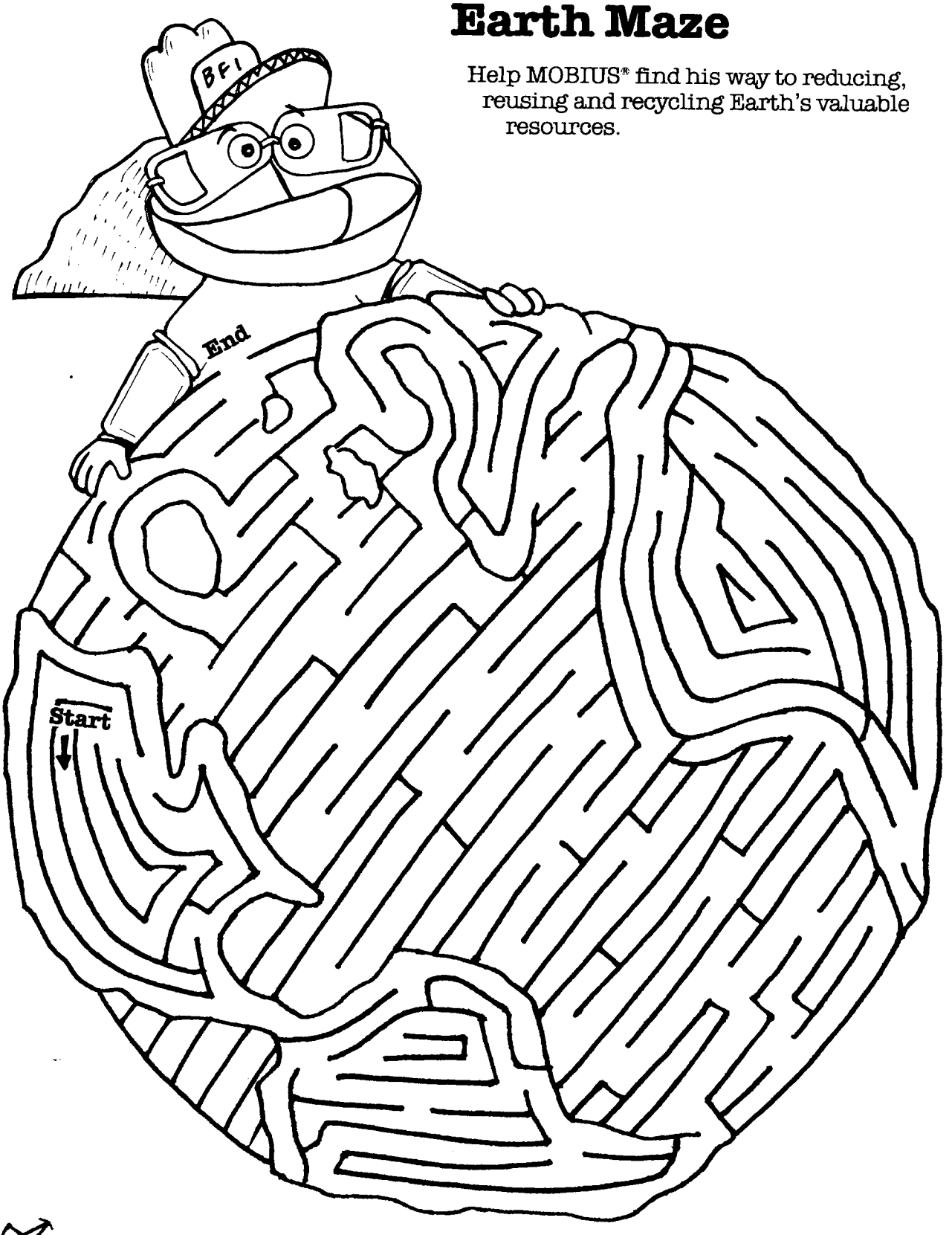
What is MOBIUS® saying? It is easy to find out. Just write down the letter of the alphabet that comes after each letter in the code. (The letter A is a triangle)

GH, LX M△LD HR
LNAHTR. CHC XNT
JMNV SG△S L△MX NE
SGD SGHMFR XNT L△X
MNV SGQNV △V△X B△M
AD TRDC △F△HM? B△MR,
ANSSKDR, O△ODQ,
B△QCAN△QC, △MC DUDM
OK△RSHB. HS'R B△KKDC
QDBXBKHMF!

Answer: Hi, my name is MOBIUS® Did you know that many of the things you may now throw away can be used again? Cans, bottles, paper, cardboard, and even plastic. It's called recycling!

Earth Maze

Help MOBIUS® find his way to reducing, reusing and recycling Earth's valuable resources.



I Think...

1. I like recycling because _____

2. The best thing about recycling is _____

3. Sometimes recycling is hard because _____

4. When I collect recyclables, I think _____

5. Learning about recycling makes me _____

6. If I see someone throw a recyclable item away, I _____

7. When I think of all the things that can be recycled and are not, I _____

8. As I grow older, I hope recycling _____

9. When I recycle at home, I hope to do a better job at _____

10. If I could change something about the way I recycle, I would _____

Word Search

Many recycling words are hidden among the letters. You will find them by looking up, down, backwards, forwards, and diagonally. Look for these words: cardboard, plastic, recycle, BFI, MOBIUS,* newspaper, glass, waste, can, compost, reuse.

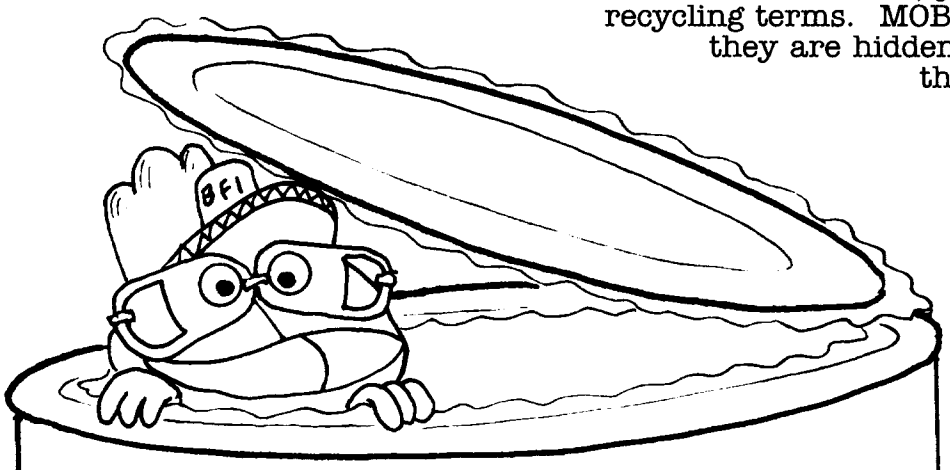
R	S	R	I	C	B	E	D
E	S	S	A	L	G	L	R
P	A	N	B	J	O	C	A
A	W	T	R	F	B	Y	O
P	L	A	S	T	I	C	B
S	U	I	B	O	M	E	D
W	A	S	T	E	O	R	R
E	U	E	S	U	E	R	A
N	T	S	O	P	M	O	C

Bottle Maze

Help MOBIUS® find his way out of the glass bottle maze.

Word Search

In the letters on the can, you' ll find many recycling terms. MOBIUS© knows where they are hidden. See if you can solve the puzzle.



W	K	F	B	M	G	E	O	W	N	I	O	Z
H	M	E	E	F	B	S	O	D	A	A	S	H
L	W	T	C	L	W	N	V	C	X	X	M	N
N	O	S	O	Q	D	U	M	D	E	R	S	U
L	O	A	T	A	V	S	Y	R	A	E	T	E
A	D	W	P	I	T	U	P	S	D	B	G	S
H	P	G	E	T	I	X	U	A	B	I	F	A
U	U	N	G	J	H	D	I	R	R	F	B	L
D	L	I	M	E	S	T	O	N	E	D	C	T
Y	P	N	F	C	E	U	V	H	G	O	L	C
Q	R	I	L	P	K	F	Y	J	K	O	J	A
Z	A	M	D	I	W	I	X	Q	L	W	N	K
T	B	E	S	K	M	W	P	J	M	O	Z	E
E	K	O	C	M	U	E	L	O	R	T	E	P
P	N	Y	A	J	L	M	K	Q	B	O	R	G

wood fiber
wood pulp
lime
salt cake
Btu
limestone
feldspar
mining waste
bauxite
petroleum coke
red mud

Crossword Puzzle

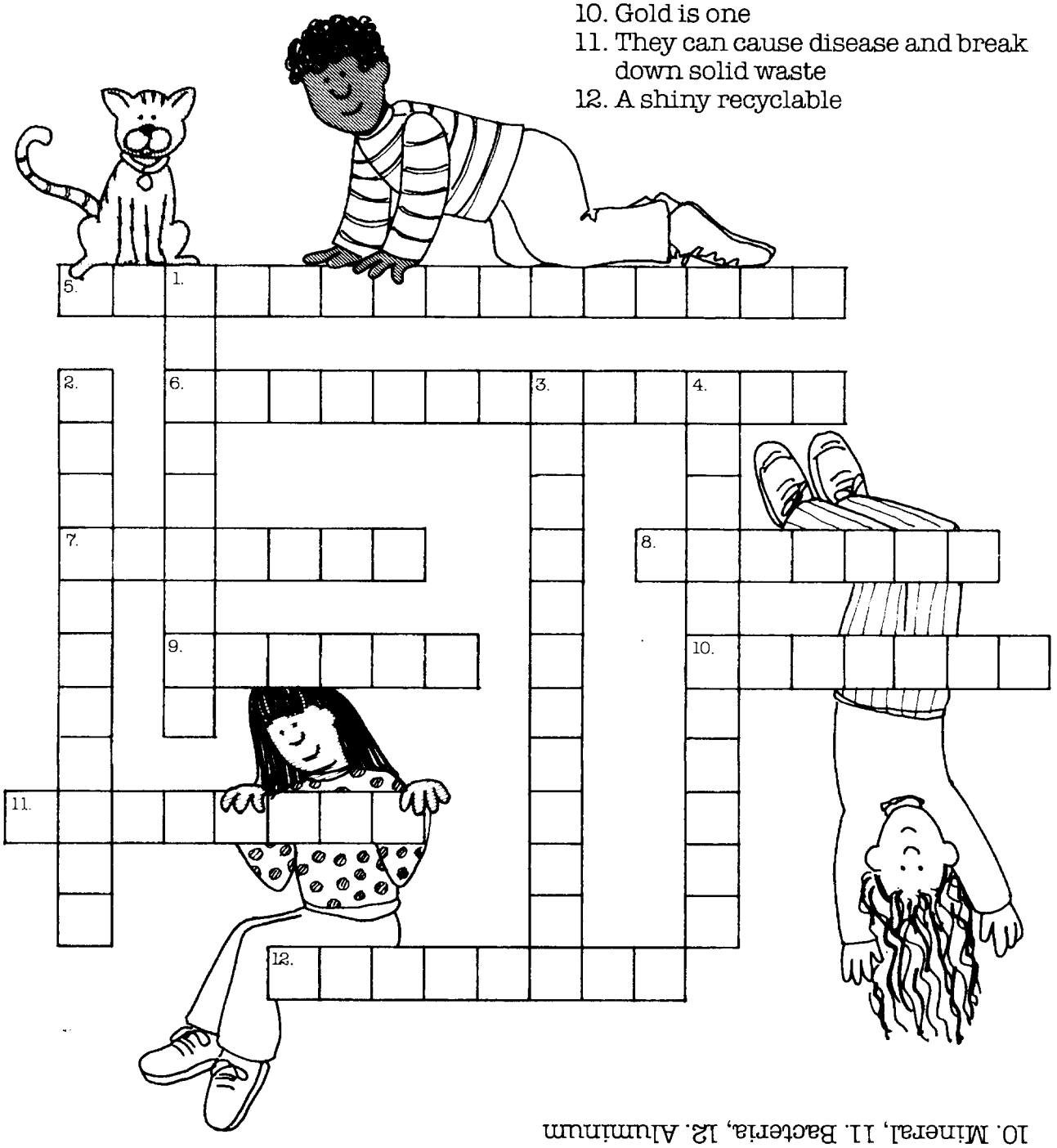
Each of the following clues refers to a word in MOBIUS® glossary.
See if you can find all the answers!

Down

1. To break down
2. To pollute
3. Part of resource recovery
4. Liquids and solids cannot pass through

Across

5. It smells like rotten eggs
6. Plants breathe _____
7. It is loaded with nutrients
8. A possible fuel
9. It often flows in pipes under the street
10. Gold is one
11. They can cause disease and break down solid waste
12. A shiny recyclable



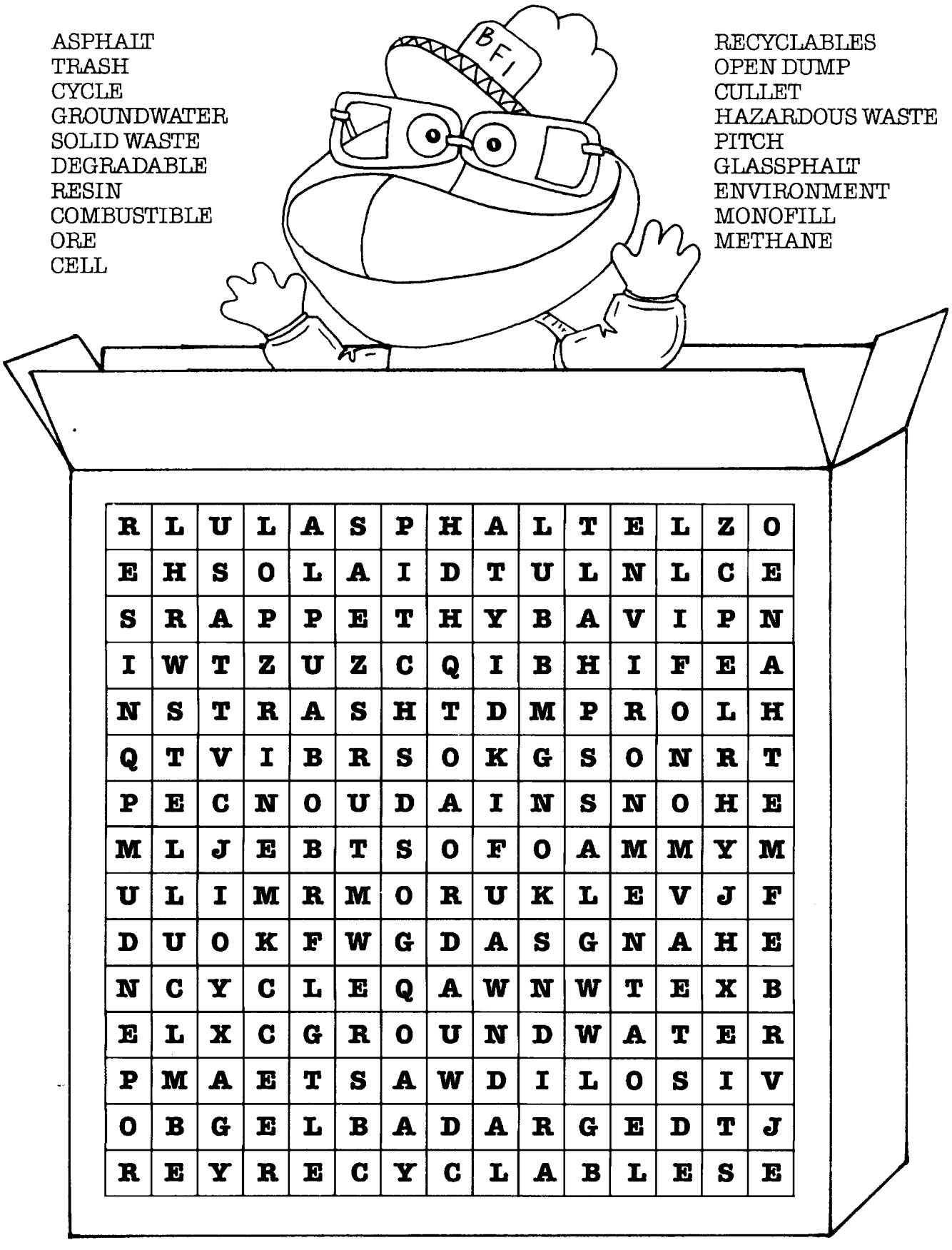
Answers: Down: 1. Decompose, 2. Contaminate, 3. Incineration, 4. Impermeable,
Across: 5. Hydrogen Sulfide, 6. Carbon Dioxide, 7. Topsoil, 8. Methane, 9. Sewage,
10. Mineral, 11. Bacteria, 12. Aluminum

Word Search

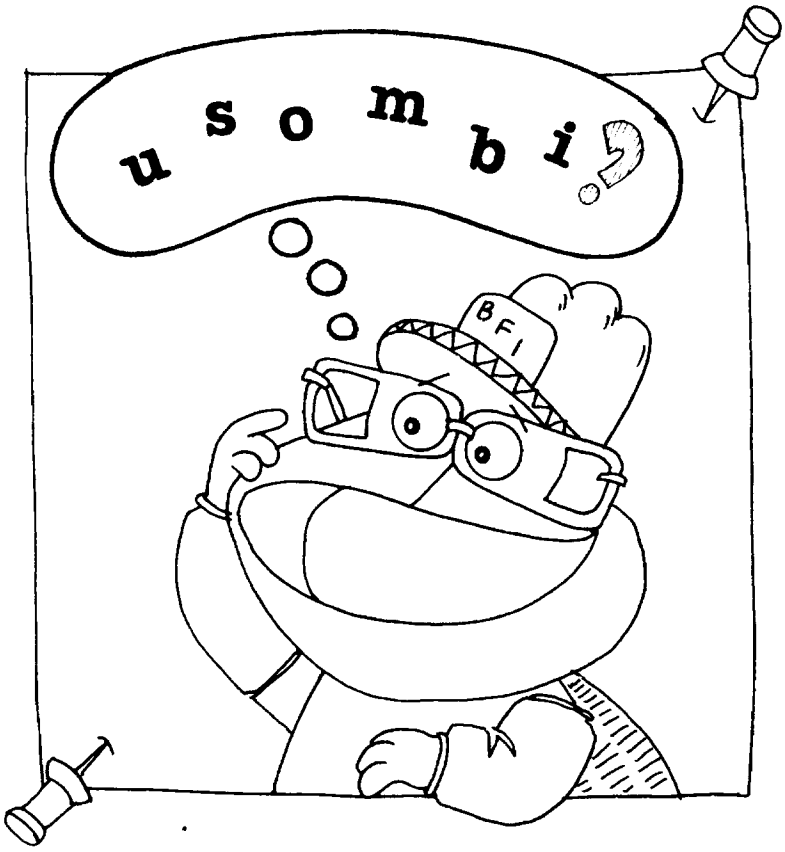
Here's a challenge you're sure to win, Find the words we've hidden within,
You can do it, there aren't too many, But we gave you a list in case you miss any.

ASPHALT
TRASH
CYCLE
GROUNDWATER
SOLID WASTE
DEGRADABLE
RESIN
COMBUSTIBLE
ORE
CELL

RECYCLABLES
OPEN DUMP
CULLET
HAZARDOUS WASTE
PITCH
GLASSPHALT
ENVIRONMENT
MONOFILL
METHANE



R	L	U	L	A	S	P	H	A	L	T	E	L	Z	O
E	H	S	O	L	A	I	D	T	U	L	N	L	C	E
S	R	A	P	P	E	T	H	Y	B	A	V	I	P	N
I	W	T	Z	U	Z	C	Q	I	B	H	I	F	E	A
N	S	T	R	A	S	H	T	D	M	P	R	O	L	H
Q	T	V	I	B	R	S	O	K	G	S	O	N	R	T
P	E	C	N	O	U	D	A	I	N	S	N	O	H	E
M	L	J	E	B	T	S	O	F	O	A	M	M	Y	M
U	L	I	M	R	M	O	R	U	K	L	E	V	J	F
D	U	O	K	F	W	G	D	A	S	G	N	A	H	E
N	C	Y	C	L	E	Q	A	W	N	W	T	E	X	B
E	L	X	C	G	R	O	U	N	D	W	A	T	E	R
P	M	A	E	T	S	A	W	D	I	L	O	S	I	V
O	B	G	E	L	B	A	D	A	R	G	E	D	T	J
R	E	Y	R	E	C	Y	C	L	A	B	L	E	S	E



Word Scramble

Each of the groups of letters here are scrambled words you've learned about recycling and the environment. First, see how many you can solve without looking at the list provided. Then, read the list and go back and see how many you recognize.

groundwater, topsoil, fiberglass, precipitation, sanitary landfill, microorganism, recyclables, aluminum, leachate, limestone, open dump, biodegradable, bacteria, combustible, impermeable, pollution, incinerator, organic, photosynthesis, monofill

1. lotiuplon

2. opsilot

3. motseneil

4. edmpupno

5. mepralmeebi

6. rnigaco

7. mumnilua

8. lofnlimo

9. ricateba

10. acethlae

11. rinsmogorcami

12. labresfisg

13. lycblaerces

14. locbmiebtus

15. dideblogebara

16. piacretnitipo

17. nraltiadsllfiayn

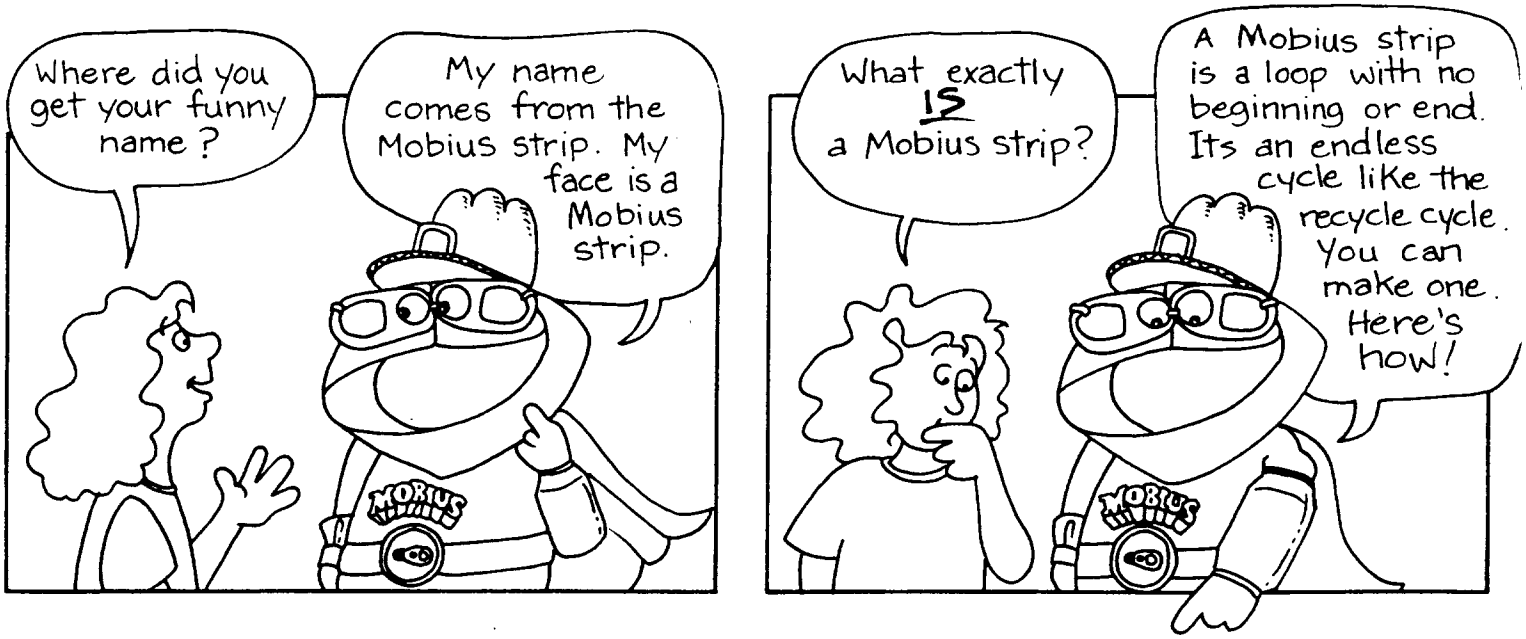
18. niecntroria

19. dwanutrorge

20. tosnphheostsyi

THE RECYCLE CYCLE

MOBIUS® Fun Book



How to make a Mobius Strip:

1. Cut a piece of paper about one inch wide and 12 inches long.
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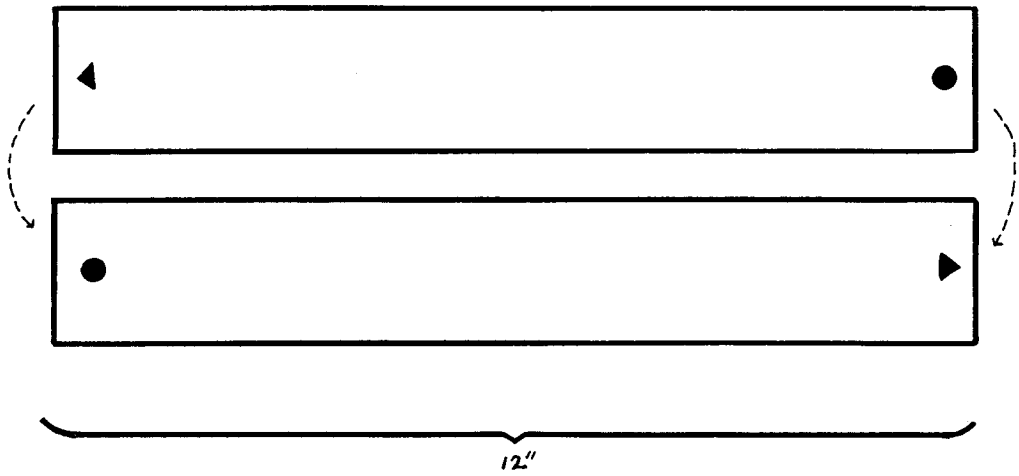
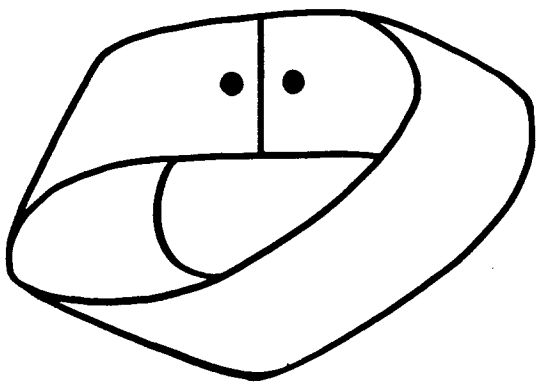
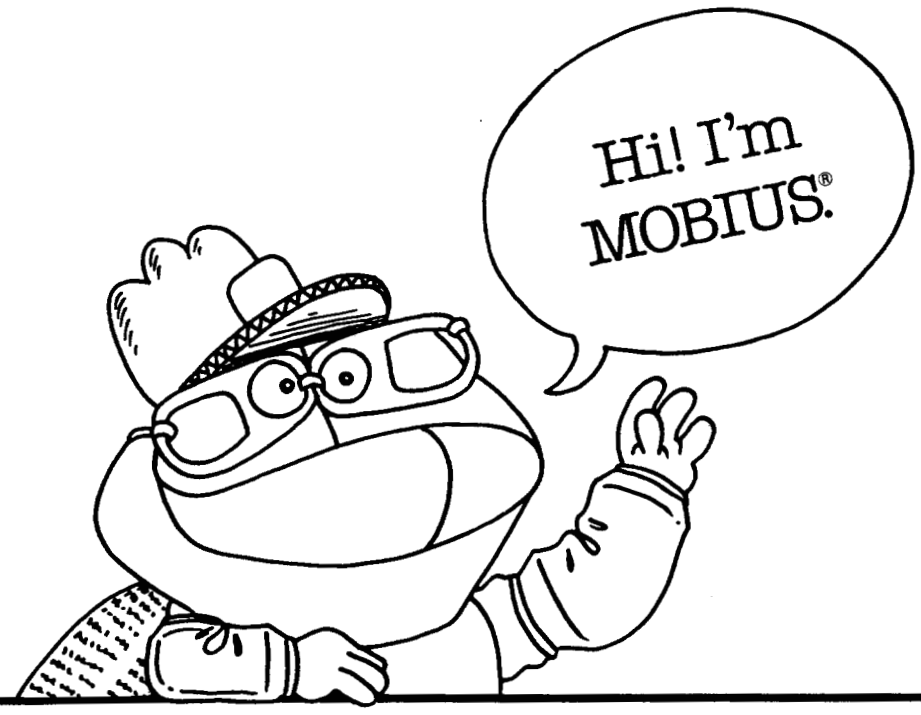




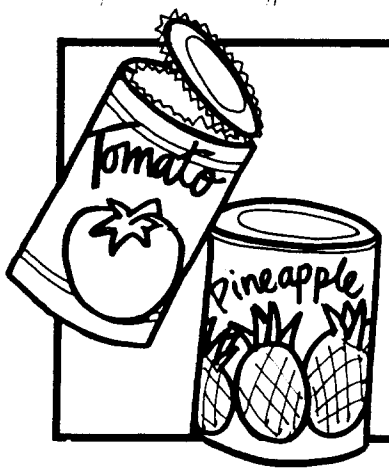


Welcome to my Fun Book. It's filled with games to play and pictures to color. But best of all it tells the story of **Recycling**. Recycling means to make new products out of old products.

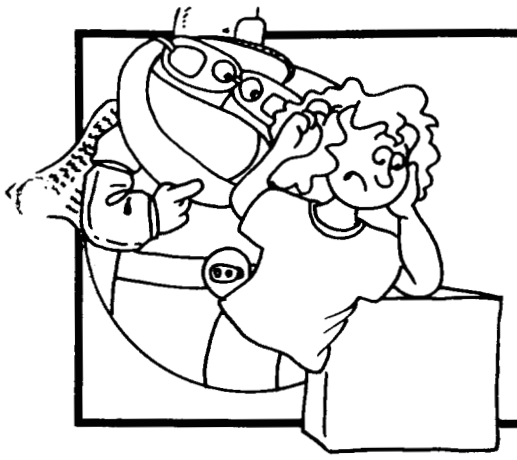
Did you know that many of the things you may now throw away can be used again? **Cans, bottles, papers, cardboard** and even **plastic** and **tires** can be used again. Some of them can be used again and again and again **forever** – unless someone throws them away!

Printed on Recycled Paper

Katie says, "I like to help my parents shop
I show them the best soda pop
We load the groceries in the cart
Buying recyclable items is smart"

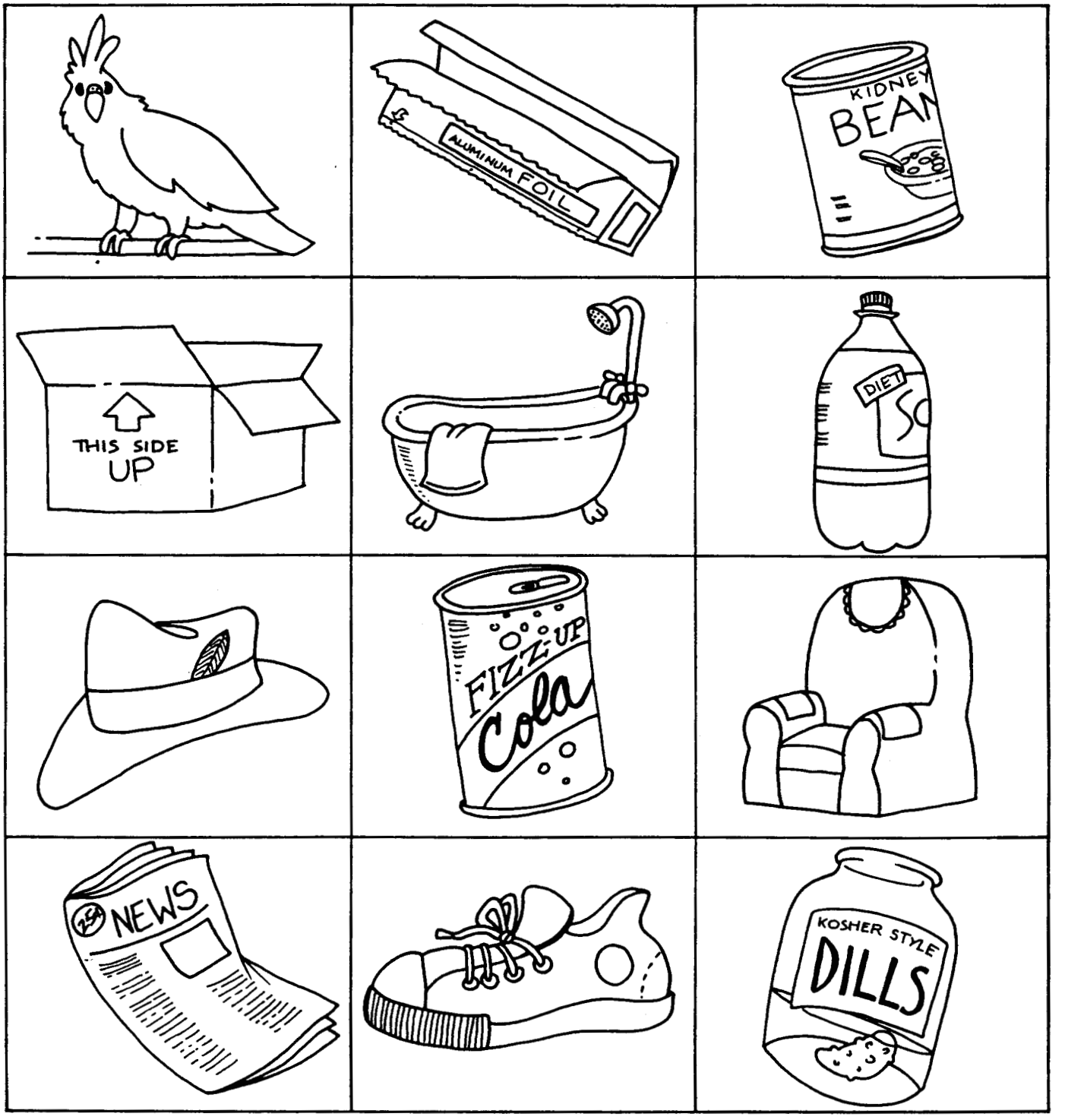


Lots is left when dinner is done
That's when Katie likes to have fun
Join her with your colorful crayons
Color the glass, paper, and cans

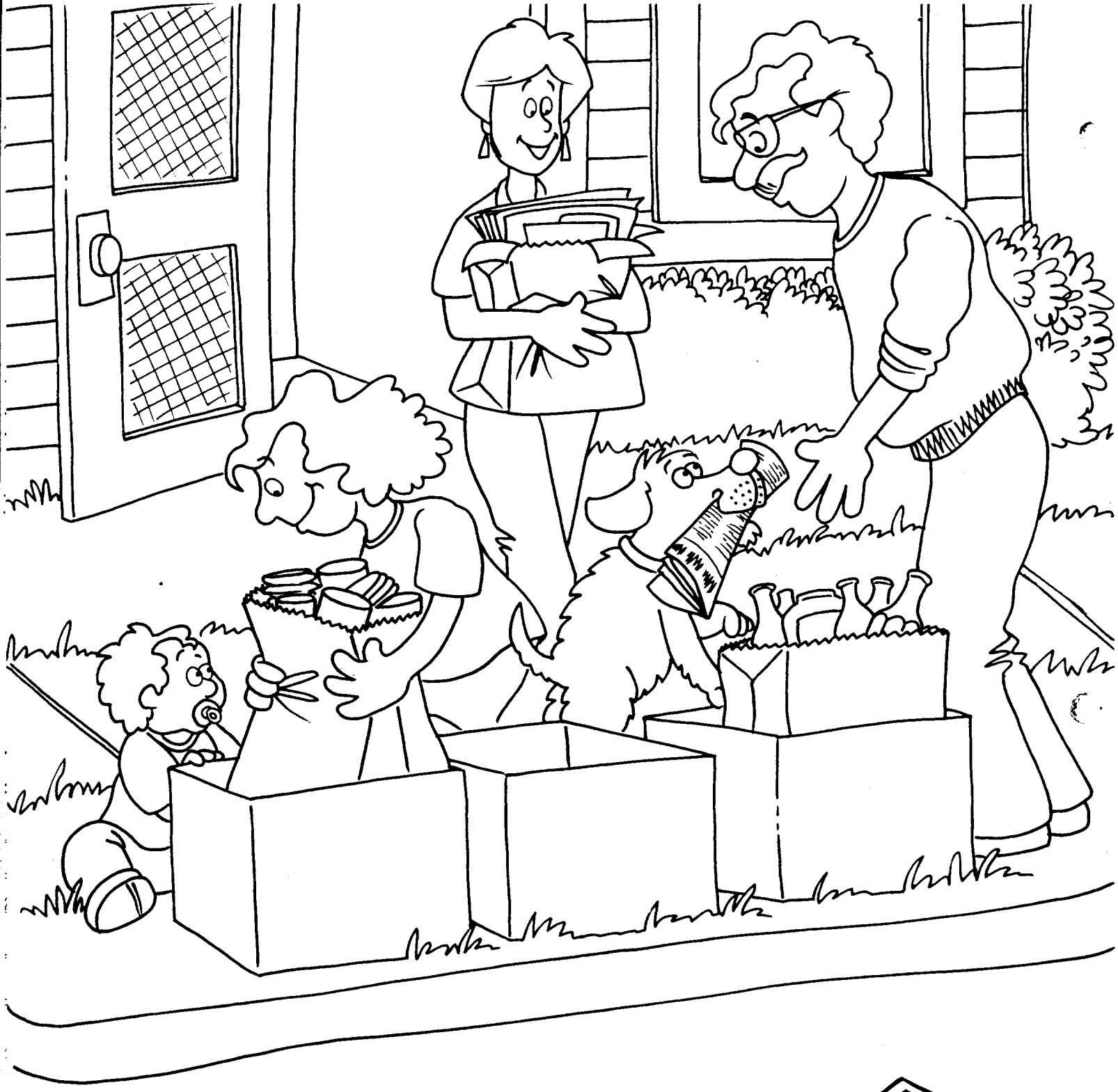


Katie says, "Clean-up is my favorite game
I call it 'recycling' by name
Many things are used again
They go into the 'recycle' bin"

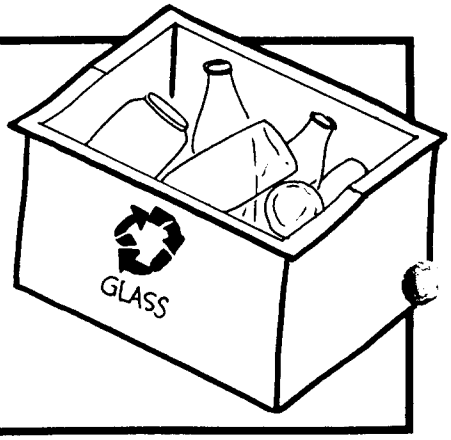
These items cannot be recycled: bird, bathtub, hat, chair, shoe.



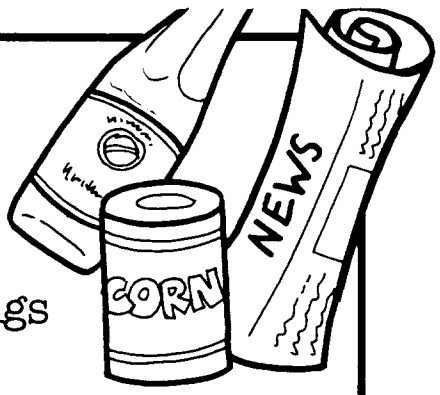
Circle the items that go into the recycle bin. These are the ones made of glass, paper, metal, and plastic. Draw an X through the other items. These cannot be "recycled" or used again.

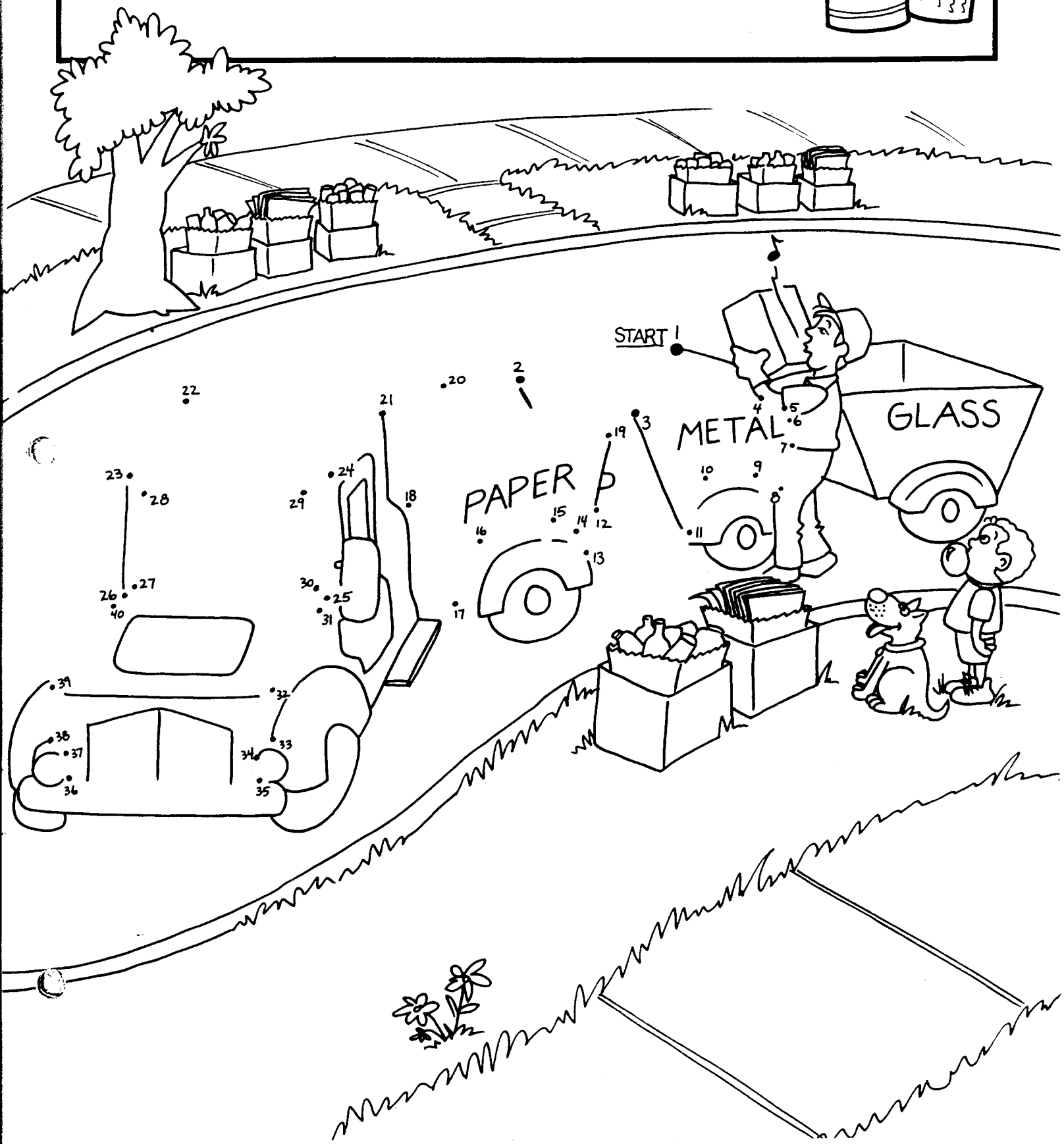


Rain, shine, snow, or sleet
We take the recycle bin out to the street
Even Blackie wants to help
He delivers the paper with a "Yelp!"



Here comes the recycle truck
Its wheels whirr, and its gears cluck-cluck
The man with the blue hat whistles and sings
As he separates the glass and the paper and things



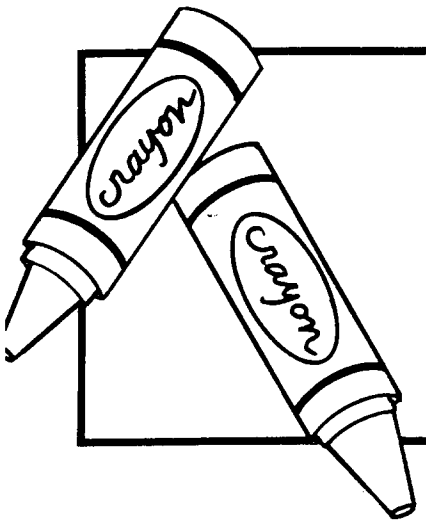


T	R	E	C	O	N	P	J
S	M	E	T	A	L	B	L
S	U	R	C	A	M	O	C
E	A	R	S	Y	O	T	G
J	E	T	M	N	C	T	L
V	I	N	S	S	A	L	G
C	R	E	P	A	P	E	E

recycle
jar
paper

bottle
can
plastic

metal
glass

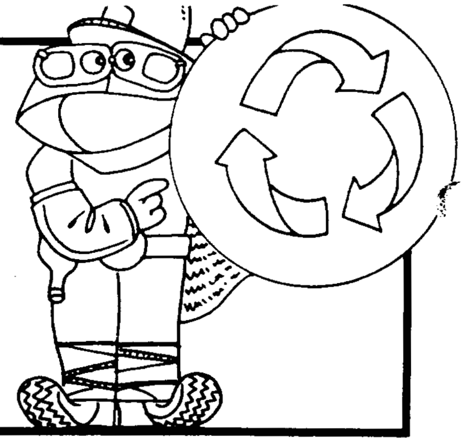


Find the letters that make a word
There are eight you've surely heard
Look up, look down, and side to side
Circle the words so they can't hide

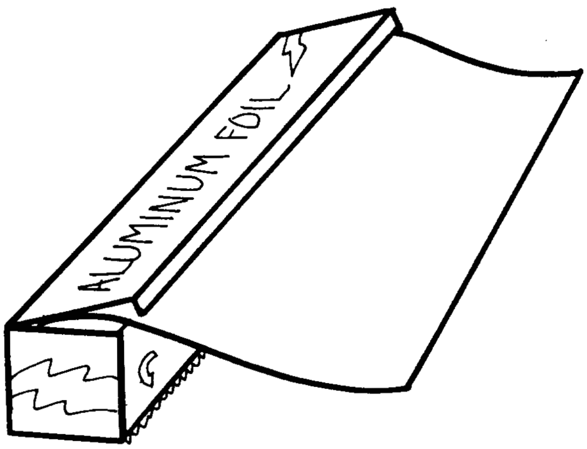
Katie travels for a day
To a jungle far away
Soon she sees that something's wrong
Find the things that don't belong

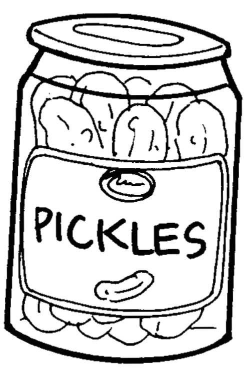
Answers: newspaper, ketchup bottle, 2 cans, soda bottle, plastic milk container, wrapped loaf of bread. MOBIUS®

To recycle is to make again
Old paper is new paper, old tin is new tin
If the materials are the same
Draw a line between them – it's a game

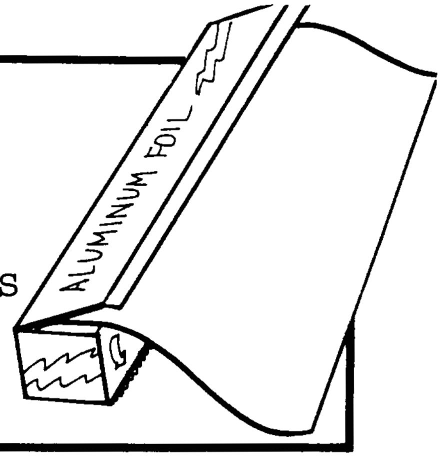


Answers: aluminum foil – soda can; newspaper – journal; pickle jar – cola bottle

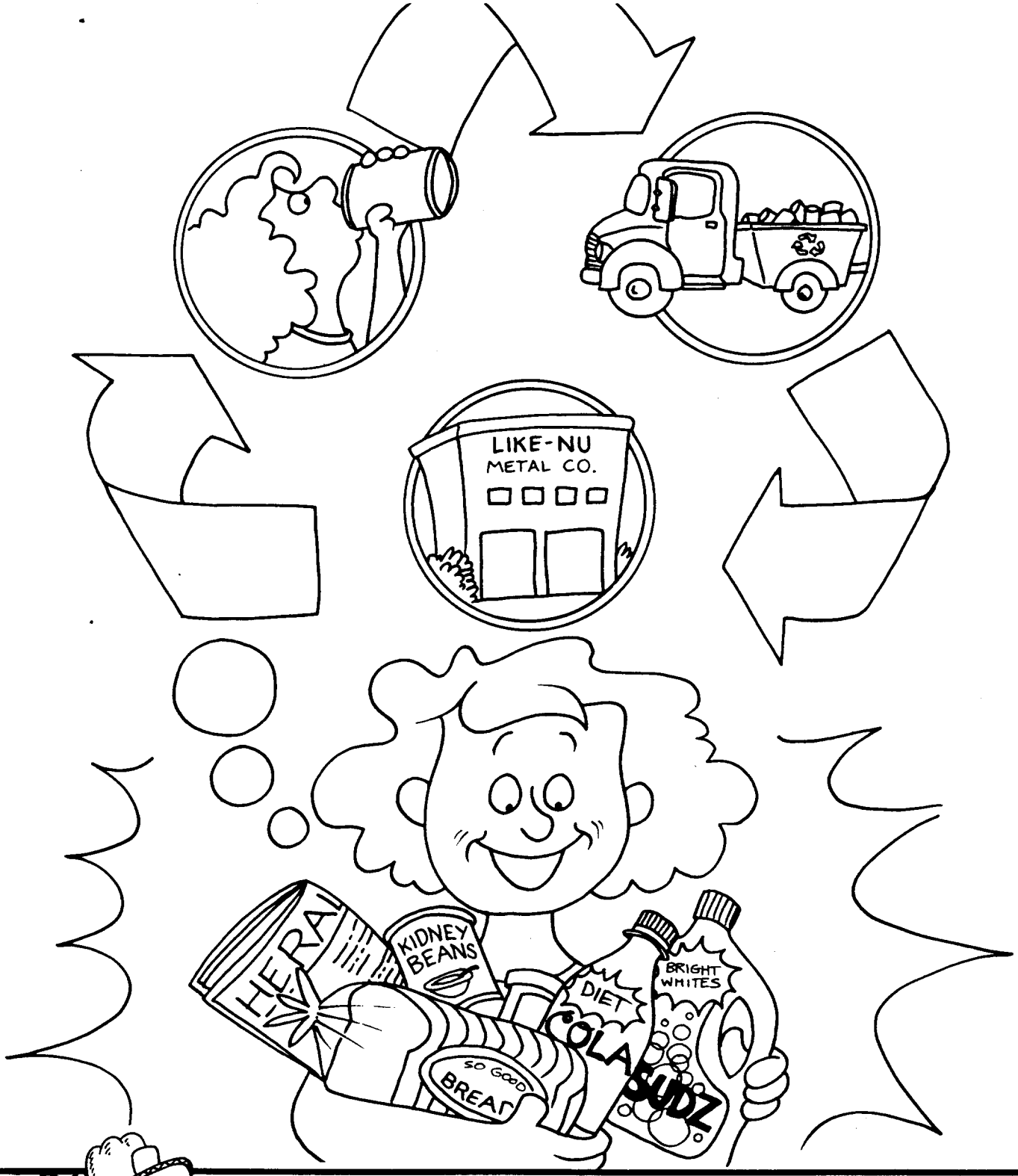




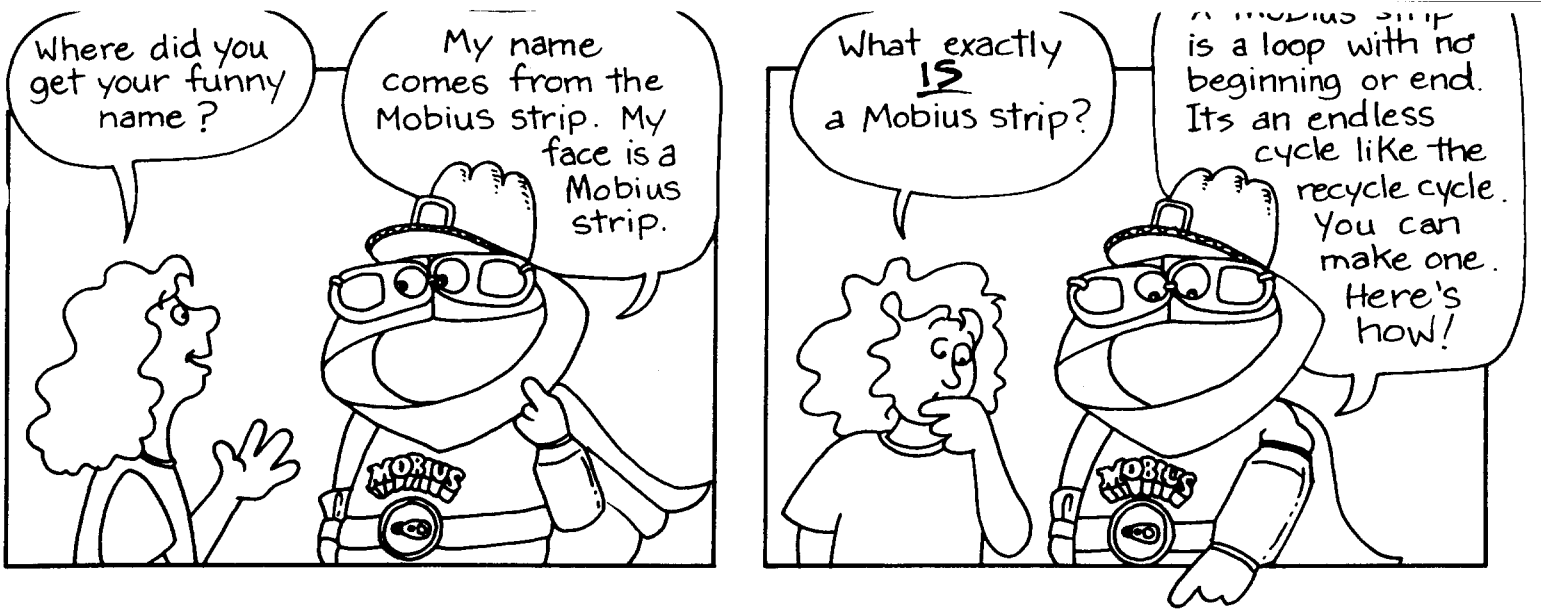
Question: Look at the items in the store
Where did you see these items before?
Clue: Not in the jungle, not in the tall grass
But where jars were made out of glass



Answer: In the Recycle Cycle



I'm glad my soda comes in a can
It can be used over again
So can paper, glass, and plastic
The Recycle Cycle is super fantastic



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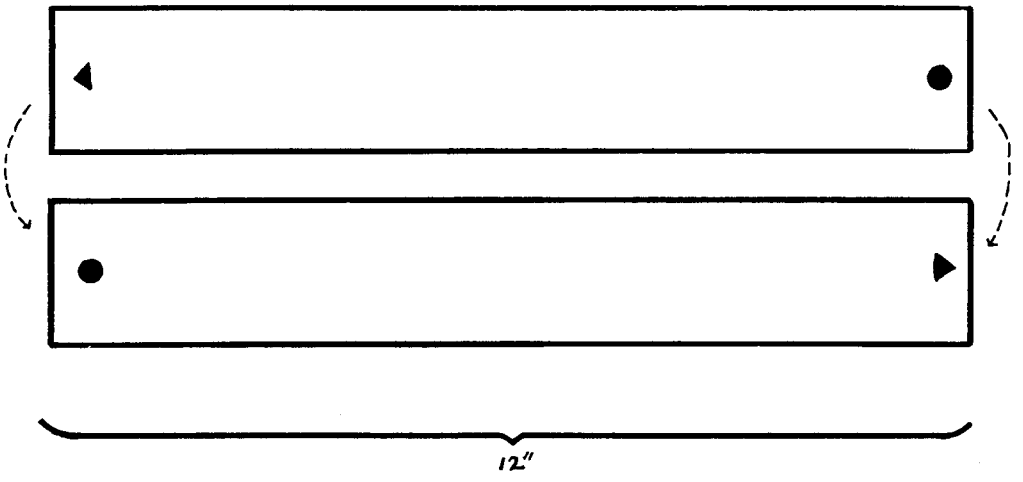
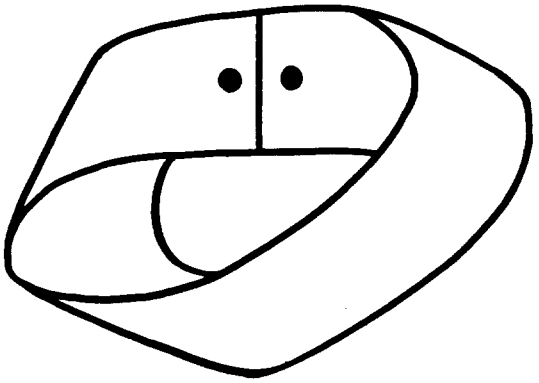
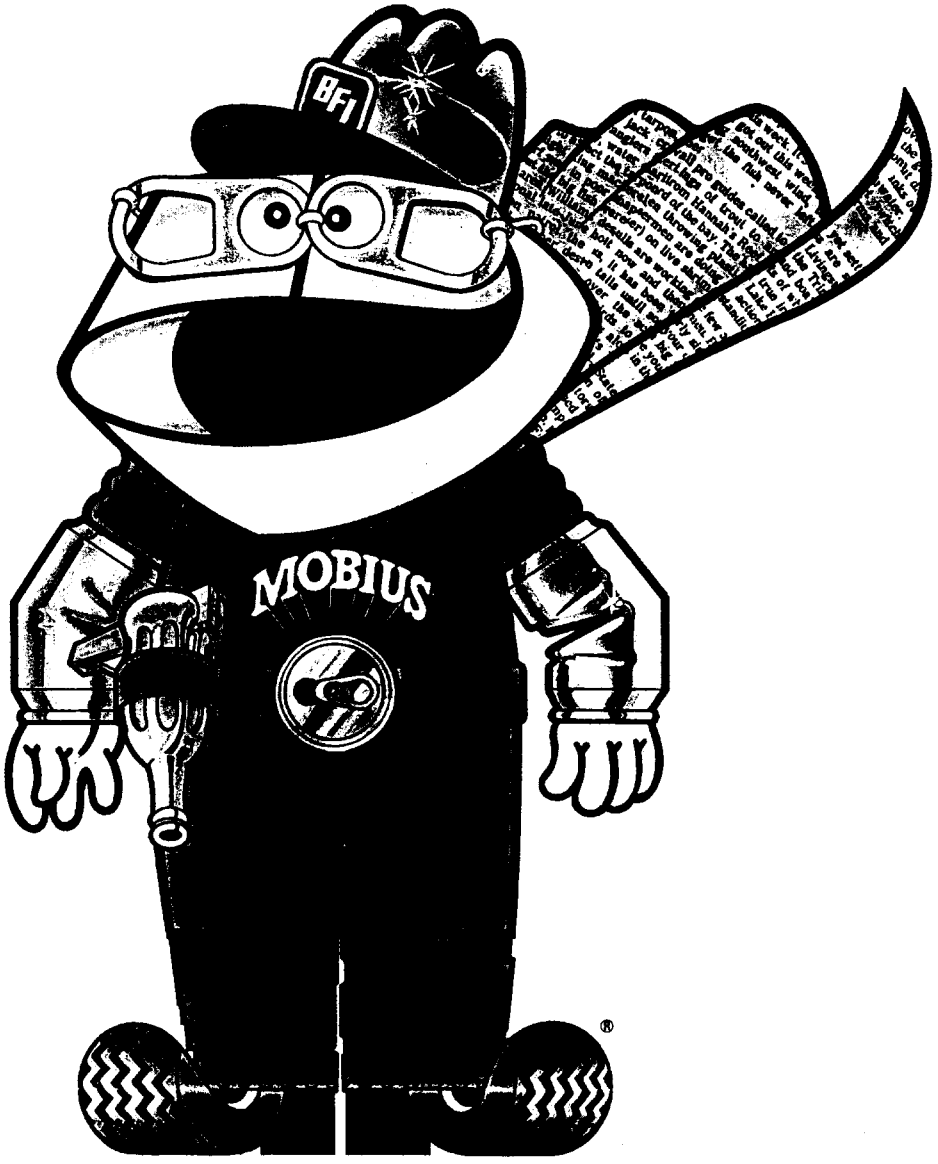




Look at me, MOBIUS®! I'm made of recycled things. Can you name the parts of my body and clothes that are made of recycled materials?

Answers: **Cans:** arms, belt buckle, eye glasses; **Paper:** cape; **Cardboard:** legs, brim of hat; **Glass:** gun; **Plastic:** crown of hat.



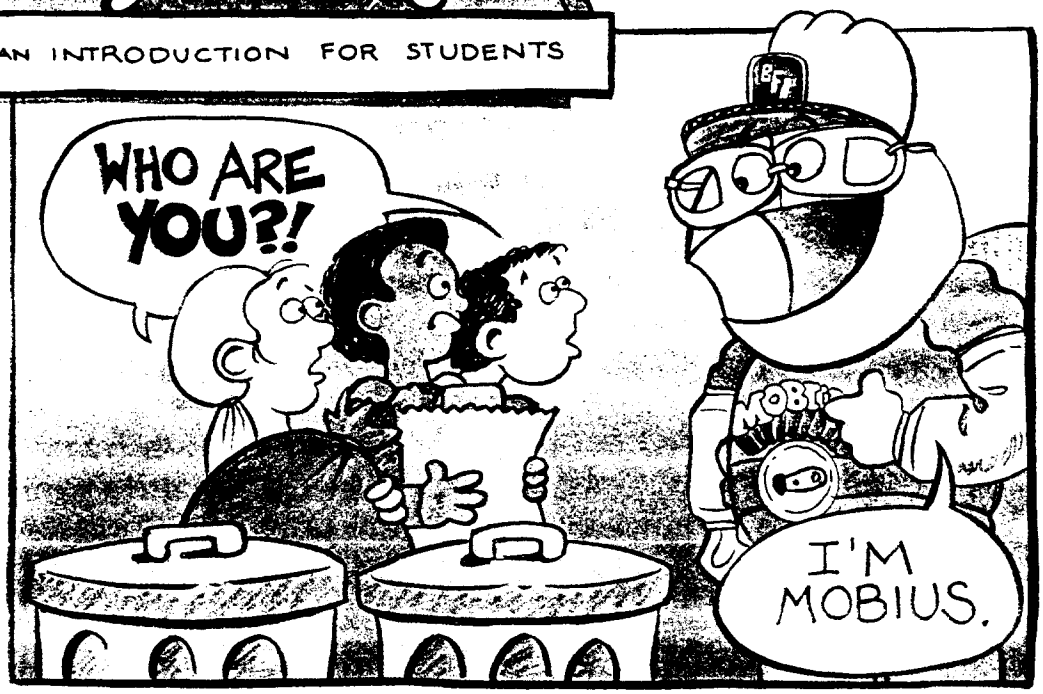
The Recycle Cycle Fun Book is part of Browning-Ferris Industries' MOBIUS® Program – an environmental education program for grade school children. For information on other available materials and contacts in your area, call the MOBIUS® Hotline: 1-800-BFI-8100.

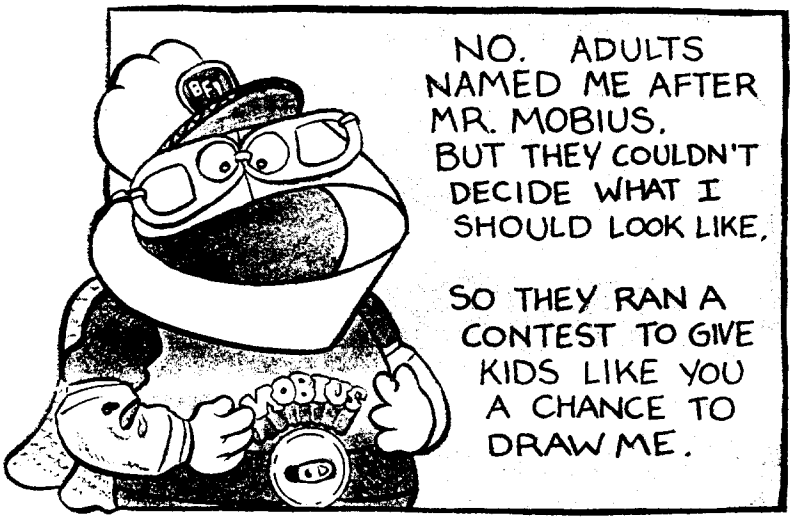
BFI®

RecycleNOW™

A CONVERSATION WITH MOBIUS

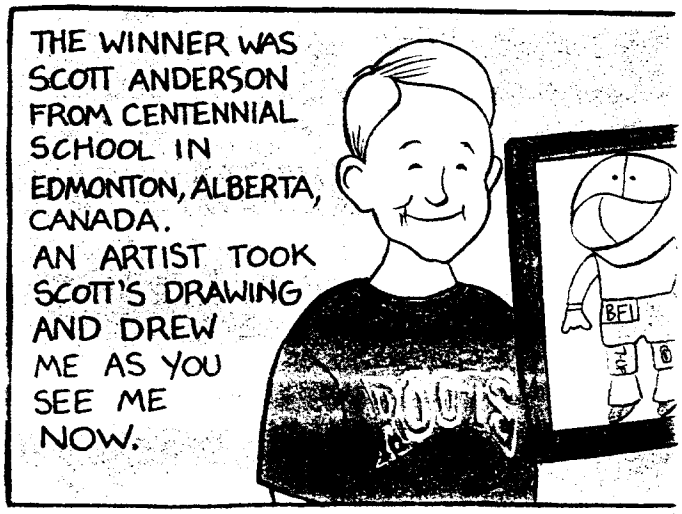
AN INTRODUCTION FOR STUDENTS





NO. ADULTS NAMED ME AFTER MR. MOBIUS. BUT THEY COULDN'T DECIDE WHAT I SHOULD LOOK LIKE.

SO THEY RAN A CONTEST TO GIVE KIDS LIKE YOU A CHANCE TO DRAW ME.

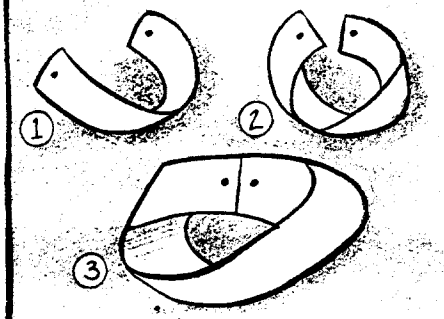


THE WINNER WAS SCOTT ANDERSON FROM CENTENNIAL SCHOOL IN EDMONTON, ALBERTA, CANADA. AN ARTIST TOOK SCOTT'S DRAWING AND DREW ME AS YOU SEE ME NOW.

BUT I'M MORE THAN A DRAWING. THE MOBIUS STRIP IS THE INTERNATIONAL SYMBOL FOR THE ENVIRONMENTAL CYCLE.

WHAT'S THAT?

I GOT MY NAME FROM A REAL GUY, AUGUSTUS F. MOBIUS. HE WAS A GERMAN MATHEMATICIAN WHO LIVED FROM 1790-1868. MOBIUS INVENTED A CONTINUOUS STRIP THAT HAD ONLY ONE SIDE. MY HEAD IS A MOBIUS STRIP.



Mobius Strip

Augustus F. Mobius
1790-1868

DID MR. MOBIUS DRAW YOU, TOO?

IT GETS PACKED INTO THE TRUCK.

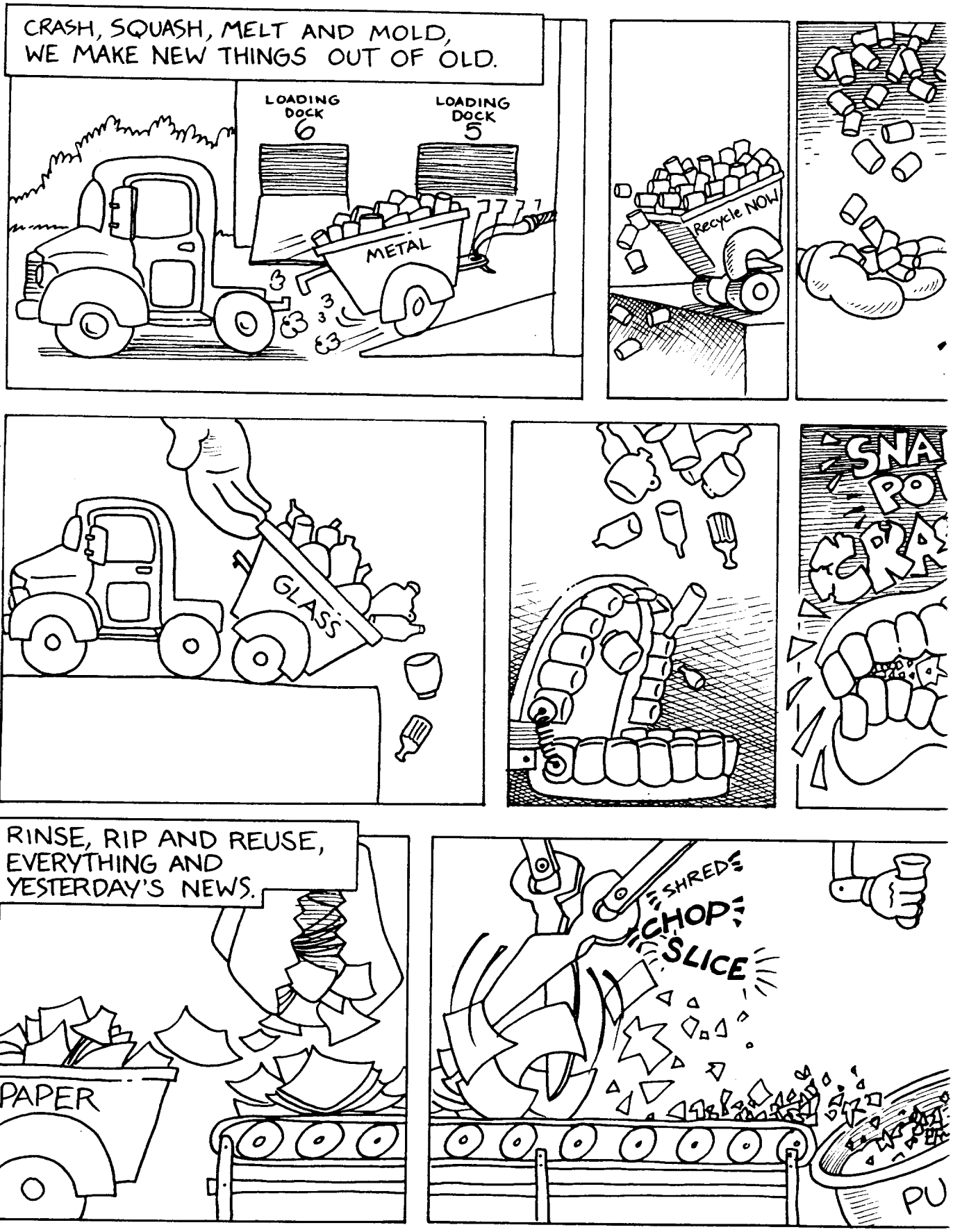
IT GETS BURIED IN THE GROUND.

THAT'S GOOD, BUT THERE'S MORE TO <u>UNDERSTANDING THE WASTE CYCLE</u>. THATS WHY I'M HERE. TOGETHER WE'LL SEE HOW THE WASTE CYCLE IS ALSO THE RESOURCE CYCLE.

WOW. ALL THAT? NEAT.

WE'LL LEARN THE THREE NEW R'S: REDUCE, REUSE AND RECYCLE. AND I'LL TEACH YOU HOW WE CAN HELP THE WORLD BECOME A BETTER, CLEANER, SAFER AND HEALTHIER PLACE TO LIVE!

THE RECYCLE C



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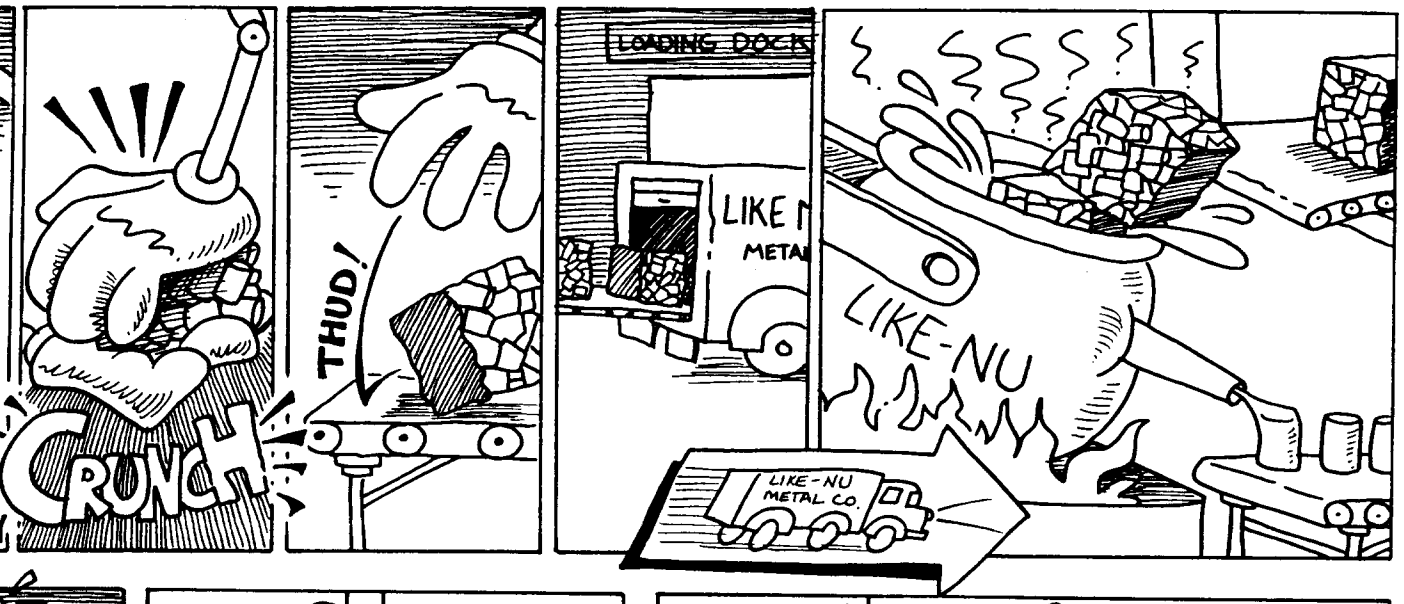
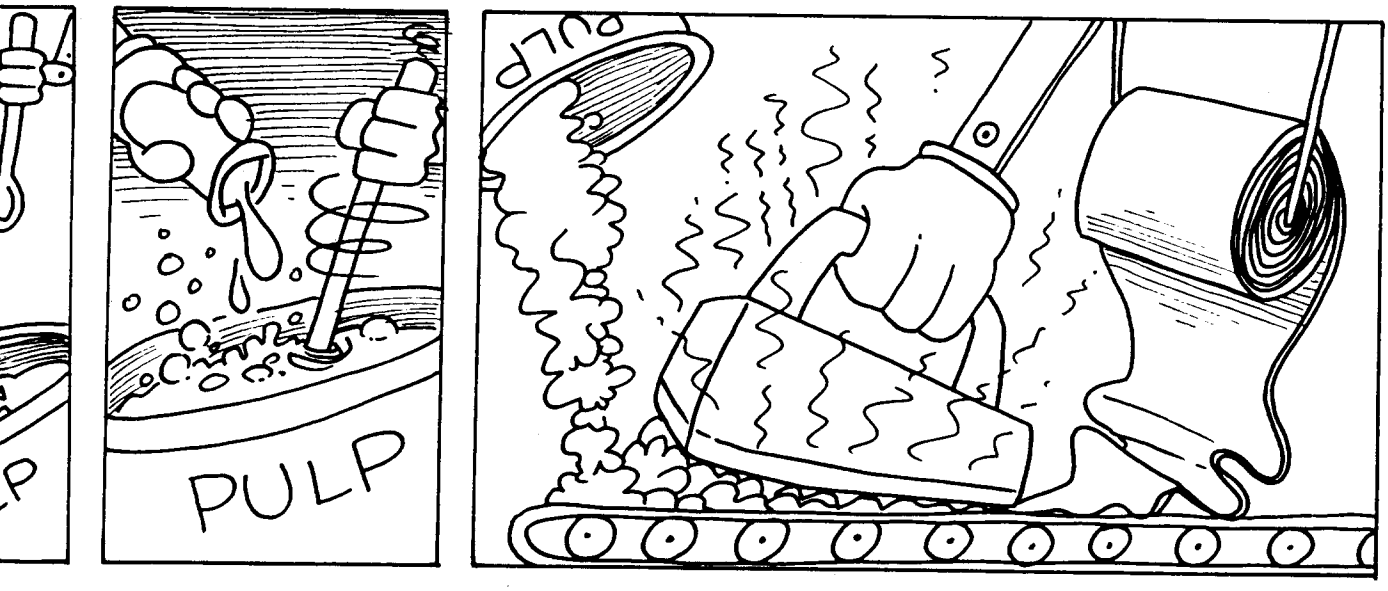

CRUNCH
THUD!
LOADING DOCK
LIKE-NU
LIKE-NU METAL CO.


MOLTEN GLASS VAT


PULP
PULP