Solid Waste Management Section

Solid Waste Introduction

The solid waste unit of the curriculum presents activities which inform the teacher and students of solid waste management problems and solutions. The activities are designed to develop awareness, attitudes, and action for waste reduction and recycling by individuals, families, schools, and communities.

The solid waste unit of the curriculum is divided into three sections. The sections reflect the Washington State solid waste management priorities.

The first section is **Reduce**. The activities in the Reduce section present strategies for reducing waste before it enters the waste stream. Activities address consumer awareness, packaging, reusing materials and composting.

The second solid waste section is **Recycle**. Activities show how to recycle, what to recycle, and why recycling is important. Activities include school recycling programs, home recycling strategies for the family, and activities that increase awareness of recycling options in the community.

The third solid waste section is **Dispose**. These activities explain the range of disposal options, list the recent improvements made in disposal and energy recovery facilities, and outline the environmental, economical, and political concerns related to the disposal of waste.

Solid waste management has been a concern for humans since the beginning of time. In early days, hunting and gathering tribes left wastes to be consumed by wild animals. Plains dwellers or nomadic people placed their wastes in one spot and when enough waste accumulated, the inhabitants moved on to a different home.

Agricultural and fishing communities gradually replaced the nomadic people. With the development of agriculture and the domestication of animals, farmers and ranchers fed their food wastes to chickens, hogs, and other farm animals. Other discarded wastes, such as pieces of metal scrap, tinned cans, and glass, were placed in pits or open dumpsites. Waste materials of wood, paper and rubber were burned in burn barrels. Large machines which had outlived their usefulness were abandoned on parcels of land unsuitable for farming.

Permanent settlements had open dumps or pits near or in villages to hold waste materials. Wastes in villages and cities were burned, buried, or simply placed in the dump. Scavenging birds and animals often infested these open dumpsites. In early settlements, tools and other items were used and reused because of limited production methods. Little packaging existed in early societies. Less waste was created, so disposal remained a small problem.

Since the industrial revolution, the influx of people into metropolitan areas has intensified problems associated with management of solid waste. Food items need extra packaging for preservation and transport from farms to cities. Technological advances have created more wastes, but also have provided more efficient ways of dealing with solid waste. Waste reduction methods, recycling programs, and modern disposal methods advance new solid waste management solutions.

Americans produced 206.9 million tons of municipal solid waste in 1993.[1] Solid waste in Washington State totaled 7.5 million tons in 1994.[2]

According to municipal solid waste sampling, each person in the United States produced 4.4 pounds of solid waste per day in 1994.[3] Educational facilities

1 EPA, Characterization of Municipal Solid Waste in the United States 1994 Update, p. 29.
2 Washington State Department of Ecology, Solid Waste in Washington State, Fourth Annual Status Report including the 1994 Recycling Survey, Publ. # 96-500, Feb. 1996, p.53.
3 EPA, Characterization of Municipal Solid Waste in the United States 1994 Update, p. 29.

surveyed in Washington State produced 240 pounds of solid waste (mostly paper and food wastes) per student in schools in 1992.[4]

Because of the growing solid waste problem, the Washington State Legislature developed a set of priorities in 1984 for the management of solid waste. These priorities for collection, handling, and management of solid waste were revised and included in Substitute House Bill 1671, passed by the Washington State Legislature in April 1989. The priorities are:[5]

1. Waste reduction (highest priority)

2. Recycling, with source separation of recyclable materials as the preferred method

3. Energy recovery, incineration or landfilling of separated waste

4. Energy recovery, incineration, or landfilling of mixed wastes

The bill further defined "solid waste" or "wastes" as "all putrescible and nonputrescible solid and semisolid wastes, including, but not limited to, garbage, rubbish ashes, industrial wastes, swill, demolition and construction wastes, abandoned vehicles or parts thereof, and recyclable materials."[6]

Reduction

The highest priority for solid waste management is waste reduction: "Waste reduction means reducing the amount or toxicity of waste generated or reusing materials."[7] Waste reduction is the prevention or elimination of waste at the point of generation. Waste reduction lessens the production or purchasing of potential waste. To distinguish waste reduction from recycling, remember that the goal of waste reduction is achieved by revising buying habits and by selective purchasing.

Composting is a waste reduction/recycling activity. It is the collection of organic materials such as lawn clippings, leaves, and kitchen scraps (no oils, fats or meats) to be covered for decomposition into fertile humus. Building and operating a compost pile of yard wastes, or using a worm bin for food wastes, provides opportunities to improve the soil and reduce the waste stream at the source. Centralized collection sites for composting are found in communities throughout the state.

Five general approaches to waste reduction are outlined by the Washington State Department of Ecology's publication Best Management Practices: Analysis For Solid Waste, 1987 Vol. 2, pp. B 12-2:

- An educational approach, aimed at consumers' purchasing habits and manufacturers' production methods.
- The incentive/disincentive approach, which utilizes economics through regulation or legislation to influence producer or consumer preference in the purchase of targeted materials (i.e., economic reward for purchasing less packaging, or a ban on certain products).
- The approach of special government programs designed to facilitate source reduction (i.e., government purchase of reusable glasses and plates rather than disposable products).
- The waste exchange approach.
- The home yard waste composting approach.

4 Washington State Department of Ecology, Solid Waste in Washington State, Fourth Annual Status Report including the 1994 Recycling Survey, Publ. # 96-500, Feb. 1996, p. 53.
5 Washington State Legislature, Substitute House Bill No. 1671, April, 1989, Sec. 1, No. 8.
6 Substitute House Bill No. 1671, April, 1989, Sec. 2, No. 16.
7 Substitute House Bill No. 1671, April, 1989, Sec. 2, No. 20.

Recycling

Recycling, which is the second priority, is "transforming or remanufacturing waste materials into usable or marketable materials rather than landfill disposal or incineration."[8] The process of recycling includes steps of separation, collection, processing, transportation to markets, and remanufacture, as well as purchase and utilization of recycled products.

Source separation recycling is the preferred method of recycling in Washington State. It occurs at the place where the waste originates, before materials enter the waste stream. Two curbside source separation recycling programs are used in Seattle. One program separates glass, paper, and metals into separate bins, the other program commingles all recyclables in one bin. Both methods separate recyclable items from household or business garbage. The Washington State Legislature set a goal "to achieve a fifty percent recycling rate by 1995. In 1994 Washington State residents recycled 38 percent of the solid waste stream."[9] On a national level, experts project that 5 to 10 percent of waste could be reduced, 25 to 30 percent could be composted, 40 to 50 percent of the waste stream could be recycled, which leaves 10 to 30 percent to be burned and/or buried.[10]

Disposal

The third and fourth priorities address disposal of solid waste. Priority three deals with energy recovery, incineration or landfilling of separated waste; priority four with the energy recovery, incineration or landfilling of mixed wastes.[11] These two priorities involve the same processes. The difference is in the composition of the waste being disposed, separated or mixed. Separated wastes have recyclable and reusable materials removed from it before disposal. Mixed wastes still contain recyclables at disposal.

Three disposal processes are listed in priorities three and four. Energy recovery reduces the volume of solid waste and converts it into usable energy by making refuse-derived fuel (RDF) or by burning solid waste in an incinerator to produce steam or electric power. Incineration is the process that reduces solid waste volume in an enclosed device using a controlled flame combustion. Landfilling is the disposal process whereby solid waste is placed in or on the land.

8 Substitute House Bill No. 1671, April, 1989, Sec. 2, No. 15.

9 Washington State Department of Ecology, Solid Waste in Washington State, Fourth Annual Status Report including the 1994 Recycling Survey, Publ. # 96-500, Feb. 1996.

10 Environmental Task Force, "Shrinking the Mountain of Waste," Resources, Vol. 6, No. 3, Summer, 1986, p. 5.

11 Substitute House Bill No. 1671, April 1989, Sec. 1, No. 8D.

Solid Waste Fact Sheets

International Facts

The average citizen in Oslo, Norway generates about 1.7 pounds of garbage per day, while the average West German, Japanese, Swiss or Swedish citizen produces 2.5 pounds of garbage per day. Source: Allen Hershkowitz, ‘‘Burning Trash: How It Could Work,’’ Technology Review, July 1987, p. 29.

In industrial countries, packaging contributes about 30 percent of weight and 50 percent of the volume of household waste. Source: Cynthia Pollack-Shea, ‘‘Realizing Recycling’s Potential,’’ State of the World 1987, New York, N.Y.: W.W. Norton Company, 1987, p. 103.

The world is now generating between 500 million and one billion tons of solid waste per year, and those figures could double every 15 years. Source: U.S. News and World Report, ‘‘Rumors of Earth’s Death Are Greatly Exaggerated,’’ May 9, 1983, p. 84.

U.S. Facts

Americans dispose of nearly four times as much garbage as the Japanese, the world’s second largest garbage producer. Source: Paul Clancy, ‘‘Recycling Efforts Take Off,’’ USA Today, November 16 , 1987, p. A 6.

The lifetime garbage of the typical American will equal at least 600 times his or her adult weight. Source: Denis Hayes, ‘‘Repairs, Reuse, Recycling: First Steps Toward a Sustainable Society.’’ Worldwatch Paper 23, Washington, D.C.: Worldwatch Institute, 1978.

After recycling and composting, the average person produced 3.4 pounds per day. In 1993, Americans threw away approximately, 2.1 million tons of appliances, 3.0 million tons of tires, 7.0 million tons of newspapers, 1.4 million tons of glass beverage containers, 0.9 million tons of aluminum beverage

What Goes Into the Solid Waste Stream?

Compare the 1992 solid waste stream for the State of Washington with that of the U.S.

U.S. 1992		*Washington State 1986*		*Washington State 1992*	
Paper	37%	Paper	40%	Paper	29%
Food	7%	Food	12%	Food	12%
Yard/Garden	17%	Yard/Garden	23%	Yard/Garden	12%
Glass	7%	Glass	6%	Glass	5%
Metals	8%	Metals	5%	Metals	7%
Plastics	9%	Plastics	9%	Plastics	10%
Wood	6%			Construction Debris	17%
Other	9%	Other	5%	Other	8%

Sources: EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update (Rounded to Nearest Percent)
Washington State Department of Ecology 1992 Washington State Characterization Study, 1993.

Metals Recycling Energy Chart

Metals (Type)	Energy Saved By Recycling
Aluminum	96%
Copper	87%
Zinc	63%
Ferrous Scrap	62%
Lead	60%

Source: Recycling Today, April 1988, p. 77

containers, 11.7 million tons of corrugated (cardboard) containers, and 7.9 million tons of plastics.

The average U.S. citizen produced 4.4 pounds of garbage per day. Source: EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update.

In 1993 in the U.S., 22 percent of municipal waste was recycled, about 16 percent was incinerated, and about 62 percent went to landfills. Source: Environmental Task Force, "Shrinking the Mountain of Waste," Resources, Vol. 6, No. 3, Summer 1986, p. 5. Ibid.

Washington State Facts

In Washington State in 1994, the average was 1.4 tons of garbage per person per year. An estimated 7.5 million tons of solid waste was produced. Source: Washington State Department of Ecology, Solid Waste in Washington State, 1996, p. 54.

One thousand tons of uncompacted waste would cover half an acre of land three feet deep. Source: U.S. News and World Report.

In Washington State in 1994, 38 percent of the waste stream was recycled. Source: Washington State Department of Ecology, Solid Waste in Washington, 1996, p. viii.

Metals

U.S. Facts

Ferrous metals such as iron and steel represented about 6.2 percent of the U.S. solid waste stream in 1993.

Aluminum represents approximately another 1.5 percent of the metals in garbage. Other non-ferrous metals such as copper and brass make up a very small share of the U.S. waste stream. The total waste stream content for metals is approximately 8 percent.

Thirty-five percent of the aluminum manufactured in the U.S. is recycled. The national rate for all metals is 30 percent. Source: EPA, Characterization of Municipal Solid Waste, 1994 Update.

Aluminum comprises only one half of one percent of the total waste stream in the U.S. By the 1990s, manufacturers plan to recycle 75 percent of all aluminum products. Source: "At a Glance," Waste Age, pamphlet, June 1988, p. 3.

If an aluminum beverage container is thrown away, as much energy is wasted as pouring out a can half-filled with gasoline. Failing to recycle a daily edition of the London Times or the Washington Post wastes just as much energy. Source: William U. Chandler, "Materials Recycling: The Virtue of Necessity," Worldwatch Paper 56, Washington, D.C.: Worldwatch Institute, 1983.

Paper

U.S. & INTERNATIONAL FACTS

County	Annual Use Per Person	Recycling Rate %
USA	580 lbs.	*26%
Sweden	477 lbs.	34%
West Germany	346 lbs.	35%
Japan	326 lbs.	45%
Spain	150 lbs.	40%
Hungry	132 lbs.	37%
South Korea	87 lbs.	37%
Brazil	64 lbs.	39%
Nigeria	7 lbs.	2%

* Waste Age reported 28% in 1986.

Source: Earth Care Paper Company. 1986 Recycled Paper Catalog. PO Box 3335, Madison, WI 53704

Paper

U.S. Facts

Approximately 38 percent of the U.S. waste stream in 1993 was paper. Source: EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update, p. 29.

Paper can be recycled several times before the fibers break down. Often reused fibers are made into packaging such as cereal boxes, gameboards, ticket stubs, and covers for hardcover books. Paper products made from recycled paper use 70 percent less energy to produce. Source: Resources, Summer 1986, p. 7.

Recovering the print run of one Sunday edition of the New York Times would leave 75,000 trees standing. Source: R.W. Beck and Associates, Solid Waste Issues and Answers, Seattle, WA.: Special Issue No. 2, 1989.

In 1993, Americans recycled 45.7 percent of their newsprint and 25.4 percent of total paper produced. Source: EPA, Characterization of Municipal Solid Waste 1994 Update.

Washington State Facts

In 1992 approximately 29 percent of the waste stream was paper. Source: Washington State Department of Ecology, 1992 Washington State Waste Characterization Studies, Vol. 1: Executive Summary, Publ. # 93-45, 1993, p. I I -27.

Washington residents recycled about 40 percent of their newsprint and 27 percent of their total paper in 1986. Source: Washington State Department of Ecology, 1986 Washington State Recycling Survey, Olympia, WA.: Washington State Department of Ecology, 1987, p. 22. (Adaptation)

In 1992, Washington residents recycled 75 percent of their newsprint and 62 percent of their high grade paper. Source: Washington State Department of Ecology, 1992 Washington State Waste Characterization Studies, 1993.

Paper products made from recycled paper used 70 percent less energy to produce than paper products from virgin timber. Source: Resources. Summer 1986, p. 7.

Glass

To recycle used glass, the glass is crushed into small pieces called cullet. The cullet is melted down to make new glass products. Glass doesn't degrade, it can last for hundreds, perhaps thousands, of years.

National Facts

In 1993, approximately 22 percent of the glass made in the U.S. was recycled. Seven percent of the U.S. solid waste stream in 1993 was glass. Source: EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update.

Washington State Facts

In 1992, 5 percent of the waste stream was glass, and in 1986, 24 percent of the glass produced was recycled. Source: Washington State Department of Ecology, 1986 Washington State Recycling Survey, Olympia, WA.: Washington State Department of Ecology, p. 22. (Adaptation)

Plastics

Plastics come in three basic forms. One form is thermoset plastics, which can be heated and molded only once. Such plastics are not degradable. Automobile bodies and bakelite used in nonstick cookware are examples of thermoset plastics.

The second type of plastics are called thermoplastics (e.g., plastic milk jugs) thermoplastics are recyclable. They may be remolded several times. Some reuses for Thermoplastics are boat docks, pallets, and filler for insulation in ski jackets.

The newest type of plastics are degradables. Some degradables can be broken down by light, others by salt water, and still others by biodegradation. Degradable plastics are not recyclable.

The plastic bottle industry has designed a national voluntary coding system for the most common plastics. The code number is placed on the base of the container. The acronyms and scientific names as well as the coding numbers are listed on p. 87.

U.S. Facts

Plastics were 9.0 percent by weight of the U.S. solid waste stream in 1993. Source: EPA, Characterization of Municipal Solid Waste in the U.S., 1994 Update.

New plastic polymers which are either biodegradable or photodegradable are being introduced in legislation and consumer markets throughout the U.S. The purpose is to protect animals, especially sea birds, and the environment.

In December 1987, the U.S. became the 29th nation to ratify a treaty prohibiting boats and ships from dumping plastics anywhere in the oceans. Source: Toufexis, ''The Dirty Seas.'' Time Magazine, p. 50.

Most plastics are polymers, made up of more than one resin. Forty-six polymers are found in different plastic products available to U.S. consumers. Source: Cynthia Pollack-Shea, ''Realizing Recycling's Potential,'' State of the World 1987, New York, N.Y.: W.W. Norton Company, p. 104.

About 8 million tons of plastic packaging was generated in the U.S. in 1993, 6.2 percent was recycled. Source: EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update.

The percentage of plastics recycled nationally has risen from .3 percent in 1980 to 3.5 percent in 1993. Source: EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update.

Plastics, because of their bulkiness, take up 20 to 30 percent of landfill space. Source: Fine, ''Nine Lives of Plastic,'' Worldwatch, p. 43.

Washington State Facts

In Washington State in 1992, plastics were approximately 10 percent of the residential and commercial solid waste stream. Source: Washington State Department of Ecology Waste Characterization Study, 1993.

In 1987, 1,665 tons of recyclable plastics were recovered. Source: Washington State Department of Ecology, News Release, September 21, 1988, p. 2.

National Voluntary Plastic Container Coding System

Number	Letters	Code	Plastic Type	Example
1	PETE		Polyethylene Terephthalate	Beverage Containers
2	HDPE		High Density Polyethylene	Milk Jugs
3	V		Vinyl/Polyethylene	Corn Oil, Shampoo Battles
4	LDPE		Low Density Polyethylene	Cosmetics Packaging
5	PP		Poly Propylene	Syrup Containers
6	PS		Poly Styrene	Cups for Hot Drinks
7	Other			

Source: The Plastic Bottle Reporter, Vol. 6, No. 3, Fall

In 1994, Washington State residents recycled approximately 29,100 tons of plastics: Source: Washington State Department of Ecology, Solid Waste in Washington State, 1996.

In 1988 a Seattle recycling company collected, compacted, and baled 50,000 pounds of plastics, mostly HDPE and LDPE, and shipped them to Hong Kong, Japan, and other ports in Asia for recycling or reuse. Source: Judith Blake, "The Complex Plastics Problem," Seattle Times, September 5, 1988, p. D3.

Washington State Litter Facts

The source for Washington State Litter Facts unless otherwise cited is: Daniel B. Syrek, Washington Litter 1987, Sacramento, CA: Institute for Applied Research, 1987. Page numbers are given in parentheses.

In Washington State in 1987, 60.9 percent of littering was deliberate littering, and 39.1 percent was accidental (i.e., unsecured loads). The most frequent litterers were pedestrians, who made 33.4 percent of all litter. Motorists were second with 20.6 percent (p. 23).

Seventy percent of all deliberate littering in Washington State is done by persons age 10 to 24. Males are responsible for 73 percent of deliberate littering (p. 25).

Fifty-one percent of accidental littering is done by people over age 35 (p. 4).

The 1995, crew of the Washington State Youth Corps cleaned 2,552 miles of highways and collected 156 tons of litter. The Corps recycled 4.2 tons of aluminum cans, 2.4 tons of scrap metal,

5.8 tons of bottles and glass, and 1.7 tons of plastic and cardboard. Another 22.6 tons of litter were collected from state parks, rest areas and other sites. Source: Washington Department of Ecology, Solid Waste in Washington State, 1996.

Washington State Solid Waste in the Workplace

Washington State Fact Source: State Department of Ecology, 1992 Waste Characterization Studies, Vol. 1: Executive Summary, Publ. # 93-45, 1992, p.11-4.

Offices generated 252 lbs. of waste per employee per year.

Dry goods retail businesses generated 1080 pounds of waste per employee per year.

Can We Do Without The Can?

Subject: All Subjects
Grades: K - 12
Teaching Time: One Week Project, Two 15–Minute Periods
Focus: Waste Reduction, Paper Recycling

Rationale

Awareness of the large volumes of paper a class throws away and informed decision making can significantly reduce a class's paper waste.

Learning Objective

Students will:

- Reduce the amount of paper they throw away.

Teacher Background

Paper Facts:

To produce one ton of paper packaging it requires:[1]

3,688 lbs. wood
216 lbs. lime
360 lbs. salt cake
76 lbs. soda ash
24,000 gals. water
28 million BTUs energy

Washington State single family households disposed of 399,331 tons of paper in 1992. This is approximately 522 pounds of paper per household:[2]

Materials

- Wastebasket
- Chart
- Graph materials

Pre & Post Test Questions

1. What percentage of the waste we produce in this classroom is paper?

2. How can we reduce the amount of paper we throw away?

Learning Procedure

1 Place the following chart on a bulletin board or wall near the basket for waste paper at a height easily accessible to students. No food wastes should be disposed of in the basket(s). Provide a small container for food wastes.

2 Ask students to write their initials and what they discarded in the appropriate space every time they throw something away. Do not discourage students from using the wastebasket(s).

3 At the end of a week, have students form small

1 Environmental Task Force, Resources, Summer 1986, Vol. 6, No. 3, p. 7.
2 Washington State Department of Ecology, 1992 Washington State Waste Characterization Study, Vol 1: Executive Summary, Publication # 93-45, July 1993, p. II-9.

	John	Sarah	Martha	George	Fay	etc. . .										
Monday																
Tuesday																
Wednesday																
Thursday																
Friday																

groups and respond to the following, drawing a bar graph from the results.

- What types of things were thrown away?
- Approximately what percentage of what was thrown out was reusable or recyclable paper?
- What additional uses could have been found for this paper?

4 Have students, working in groups, draw large butcher paper graphs plotting days on the horizontal axis and the number of visits to the wastebasket on the vertical axis.

5 Have groups compare their lists of composition, estimated percentages, and alternate uses for discards.

6 At the end of the week, conduct the activity, ‘‘Would You Do It If I Taught You? If I Paid You?,’’ p. 123.

7 After completing ‘‘Would You Do It If I Taught You? If I Paid You?,’’ put up a new chart near the wastebasket and repeat the activity.

8 Discuss and compare the results as reflected on the bar graphs. Emphasize the effect awareness and informed decision making can have on the reuse or recycling of paper and on ‘‘doing without the can.’’

Extended Learning

1 With the cooperation of the custodian, remove wastebasket(s) entirely for a week. Explain to students that no classroom waste will be disposed of inside or outside of the classroom. Point out that many counties and cities across the United States are faced with this situation of producing waste but having few choices about where to put it.
Ask students to develop a plan for storing all classroom waste for one week. Explain that at the end of the week students will separate and quantify the waste.

2 At the end of the week, weigh the amount of accumulated waste to come up with a per-day and per-person average.

3 Separate materials and recycle.

4 Discuss ways to reduce the volume of waste the class produces.

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Washington State Department of Ecology. 1992 Washington State Waste Characterization Study. Vol. 1-6, 1993.

Waste, Then And Now

Subjects: Social Studies, Home Economics, American History

Grades: 5-12

Teaching Time: 30 Minutes

Focus: Waste Reduction, Packaging

Rationale

Americans are often pictured as very wasteful in the consumption of goods and materials. According to one article, "Americans are the most wasteful people on earth. Every day, 410,000 tons of banana peels, newspapers, automobile tires, and other items are discarded in the United States."[1] The complexity of our way of life contributes greatly to the amount of trash we produce. If we compare our way of life to a simpler one, such as that of the early American Indian, we may be able to get some ideas on how to reduce both our consumption and our waste.

Learning Objective

Students will:

- Identify reasons why the way of life of some Americans contributes to our country's massive trash problem.
- Identify ways to revise their way of life so as to reduce the amount of waste they produce.

Teacher Background

In industrial countries, packaging contributes about 30 percent of the weight and 50 percent of the volume of household waste.[2]

1993 Containers and packaging in the U.S. solid waste stream:

(before recycling)

Steel	1.4%	3 million tons
Aluminum	1.0%	1.9 million tons
Glass	5.9%	12.2 million tons
Paper & paperboard	17.1%	35.4 million tons
(includes corrugated containers,cereal boxes, and grocery sacks)		
Plastics	4.0%	8.2 million tons
Wood	4.6%	9.4 million tons

(From: EPA Characterization of Municipal Solid Waste in the U.S., 1994 Update, p. 67-68.)

Pre & Post Test Questions

1. What is the relationship between a standard of living and the generation of solid waste?

2. What is planned obsolescence?

Learning Procedure

1 Food packaging contributes greatly to America's trash problem.

- List the trash produced through the consumption of foods (cans, boxes, plastic and glass bottles, paper products, plastic bags, and organic garbage).
- Discuss: How did the Indians obtain food? (hunting, gathering, fishing, farming, animal husbandry)
- Discuss: Did the Indians have a disposal problem? What did they do about it?

1 Ken Sands, "Garbage: A Nationwide Problem" Spokesman Review, March 17, 1985.

2 Cynthia Pollack-Shea, "Realizing Recycling's Potential," State of the World 1987, New York, N.Y.: W.W. Norton, 1987, p. 103.

- Why were trash problems then different from those now?
- Discuss: In what ways could we incorporate or modify Indian methods in order to produce smaller amounts of trash (grow our own food and animals, use biodegradable packaging, buy more unprocessed food).

2 In our society, we use tools of all kinds from disposable razor blades to electric can openers. When these items are broken or worn, we often discard them as trash.

- What tools or appliances have you used and thrown away in your household?
- What is planned obsolescence?
- What tools did the Indians use? (bones, bows and arrows, spears, knives, scrapers, bone awls, or needles)
- What might we do the next time a tool or appliances is broken? (try to repair it, compare cost of repair to replacement cost)

3 When we outgrow clothing, it goes out of style, or it gets worn, we often throw it into the trash.

- Why would Indians have been unlikely to throw away old clothing? (hard to obtain, was resewn into something else, didn't have excess clothing)
- What might you do to reduce clothing waste? (give outgrown clothing away, don't buy too much, repair worn clothing, buy durable clothing that is less susceptible to changes in style)

4 Can you think of items the Indians did not have which contribute to our trash problems? (cars, tires, newspapers, paper of all kinds, and plastic) Can you think of ways to reduce these kinds of trash?

5 Conclusion:

- Why do we produce more trash than the Indians did? (complexity of our culture – we don't make our own tools and clothing or directly obtain our own food; we use more manufactured and nonbiodegradable materials)
- What reasons can you think of for reducing waste? (reduce disposal costs, conserve energy and resources, improve the health of the environment)
- List some things you will do to reduce waste in your home.

Resources

Video Tape: Home. The Radio and TV Commission of the Southern Baptist Convention. 1972. 20 min.

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A Careful Consumer's Trip To The Grocery Store

Subjects: Home Economics, Social Studies
Grades: 6-12
Teaching Time: 40 Minutes
Focus: Waste Reduction, Resource Conservation, Consumer Awareness

Rationale

Careful buying is the first solution to the problem of too much solid waste. An individual's careful buying decisions can significantly reduce the volume of household waste.

Learning Objective

Students will understand:

- How recycled materials are used in packaging.
- Which natural resources are used in packaging and how these resources can be conserved through careful buying and recycling.
- That, because approximately 30 percent of municipal waste consists of containers and packaging,[1] responsible buying choices can reduce Washington's waste stream.

Teacher Background

Nearly a $1 out of every $10 spent for food and beverages in the United States pays for packaging.[2] The packaging bill in 1986 in the United States totaled $28 billion.[3] Americans spent more for food packaging in 1986 than farmers received in income.[4]

Materials

- Survey 1 - "Product and Packaging Chart"
- Survey 2a and 2b - "A Potato By Any Other Name"

Pre & Post Test Questions

1. Approximately what percentage of the cost of packaged foods you buy goes for packaging?

2. How can you reduce the amount of packaging you throw away?

Learning Procedure

1 For homework, have students conduct a survey of some grocery store products and packaging.

2 Review definitions of survey terms:
ORGANIC -- derived from living organisms.
RENEWABLE RESOURCES – naturally occurring raw materials derived from an endless or cyclical source such as the sun, wind, falling water (hydroelectricity), fish, and trees. With careful management, the consumption of these resources can be approximately equal to replacement by natural or human-assisted systems.

NONRENEWABLE RESOURCES – naturally occurring raw materials which, because of their scarcity, the great length of time required for their formation, or their rapid depletion, are considered exhaustible. In other words, when they are gone, they are gone. Example: petroleum.

1 Franklin Associates LTD., Characterization of Municipal Solid Waste in the United States, 1960 to 2000: Update 1988, Prairie Village, KS: Franklin Associates LTD., 1988, p. 15.
2 Cynthia Pollack-Shea, "Realizing Recycling's Potential," State of the World 1987, New York, N.Y.: W.W. Norton, 1987, p. 103.
3 Ibid.
4 Ibid.

3 Review how to identify packaging made from recycled materials – look for the recycling symbol. The gray paperboard used for cereal boxes is made from recycled paper.

4 Review survey forms, distribute surveys – "Product and Packaging Chart" and "A Potato By Any Other Name."

5 Give assignments:

Survey 1: Product and Packaging Chart

1. Choose ten products and complete the Survey 1 chart for each.
2. Choose at least two products available in a choice of packaging.
3. By examining the products you chose, answer the following questions:
   - Which products need special packaging to protect public health?
   - Which product's packaging was made from recycled materials? (Look for recycling symbol.)
   - Which products could be bought in bulk or in large containers?
   - Which products could be bought in a less processed or packaged form?
   - Which product's packaging could be improved to save energy and resources and reduce waste?

Survey 2

Find as many potato products as you can, at least ten. Use the chart "A Potato By Any Other Name" as a guide. Fill in the chart on Survey 2.

NOTE: Price-per-pound listing can be found on shelf labels beneath products. Analyze and discuss your findings:

1. What effect does processing and packaging have on a product's cost?
2. What effect does package size have on price?
3. What effect does package size have on the amount of waste?
4. What else is added to food as it becomes more highly processed?
5. List examples of recyclable packaging.
6. List examples of products for which recyclable packaging is not even a choice.
7. List examples of packaging made from recycled materials.
8. List ways people can reduce waste and increase recycling through careful buying.

Extended Learning

Visit a food co-op and see their solution to the problem of too much packaging.

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A POTATO BY ANY OTHER NAME

Product	Package Size	Price	Price Per Pound
Russets potatoes	Bulk		$ .59
White potatoes	Bulk		.49
Red potatoes	Bulk		.69
Fresh potatoes	5 lb.	$1.67	.338
Fresh potatoes	10 lb.	2.49	.249
Fresh potatoes	15 lb.	3.49	.232
Bel-Air* hash browns	2 lb.	1.29	.645
Bel-Air* french fries	2 lb.	1.59	.795
Bel-Air shoestring potatoes	20 lb.	1.39	1.12
Ore-Ida potatoes O'Brien	24 lb.	1.49	.994
Ore-Ida golden fries	32 lb.	1.69	.85
Ore-Ida dinner fries	24 lb.	1.79	1.20
Betty Crocker potato buds (box)	28 lb.	2.99	1.70
Betty Crocker potato buds (box)	13.75 oz.	1.49	1.73
Town House mashed potatoes (box)	16 oz.	1.39	1.39
Town House white potatoes (canned)	15 oz.	.57	.608
S & W whole potatoes (canned)	16 oz.	.75	.75
O'Boises potato chips	6.5 oz.	1.15	2.83
Eagle potato chips	6.5 oz.	1.09	2.68
Pringles	7 oz.	1.50	3.42
Lays potato chips	7 oz.	1.58	3.61
Lays potato chips	10.5 oz.	2.28	3.47
Ruffles potato chips	15 oz.	2.75	2.93
Nalley's potato chips	16 oz.	2.65	2.65
Small order McDonald's french fries	3.5 oz.	.67	3.06

* *Bel-Air is a Safeway Stores, Inc. private label. All store items were priced on July 13, 1989, at Safeway in Redmond, Washington; McDonald's priced on July 22, 1989, in Redmond, Washington.*

Survey 1.

PRODUCT AND PACKAGING CHART

Product	Renewable Recyclable (e.g., paper)		Nonrenewable Resource (e.g., petroleum)		Is this product necessary?	Is this product available in more than one form of packaging?	If so, which is best in terms of recycling and waste reduction?	Is there an alternative to this product?	How could the packaging be improved to save resources and energy?	What happens to this product's package when the contents are used?	Will this product's packaging become part of Washington's waste stream?
	Organic (derived from living organisms)	Renewable Recyclable Packaging	Nonrenewable Recyclable Packaging	Nonrenewable Nonrecyclable Packaging							

Survey 2

A POTATO BY ANY OTHER NAME

Product	Package Size	Price	Price Per Pound

Putting Your Product In A Package

Subjects: Consumer Education, Business, Economics, Design, Industrial Arts
Grades: 7-12
Teaching Time: 45 Minutes
Focus: Packaging, Waste Reduction

Rationale

Packaging is the largest single component of household solid waste.[1] Many materials produced for the marketplace, however, need to be packaged in order to protect them during shipping. At the retail outlet, packaging serves to advertise products and identify contents, and may be required to meet regulatory standards.

Learning Objective

Students will:

- Understand som the benefits and drawbacks of packaging.
- Understand the function packaging plays in protecting and marketing products.
- Design packages which reflect their awareness of the waste reduction and resource conservation consequences of packaging decisions.

Materials

- The packaged products listed on the worksheet.
- "Packaging Information Sheet" and "Packaged Products Worksheet."
- Materials for design/construction of prototype packages.

Pre & Post Test Questions

1. Why are products packaged?

2. What are the benefits and drawbacks of packaging?

1 Peter T. White "The Fascinating World of Trash," National Geographic, April 1984, Vol. 163, No. 4, pp. 424-457.

2 Divide students into groups. To each group distribute all products in one category. Product categories are listed on the following "packaged products worksheet."

3 Ask each student to design a new package for a product of his or her choice.

4 Discuss with students the "Packaging Information Sheet."

5 Ask students to list on the worksheet the function and design considerations they feel are important in designing the packaging of the products they are examining. **Ask:** "Why did the producer package his product this way?" "How else might this product have been packaged?"

6 Ask students to identify the packages which could be reused or recycled.

Ask: "How can we reuse or recycle the packaging materials after we have used the products?"

Ask: "What will happen to the packaging we cannot reuse or recycle?"

Ask: "How can we as consumers reduce the 7.6 pounds of waste we, in Washington State, produce everyday?"

7 Using the "Packaging Information Sheet," have students develop design specifications for the packaging they will create. Challenge students by explaining their designs must include considerations of waste reduction, reuse, and recycling, as well as public safety, product protection, shipping weight, cost of packaging material, advertising, and public demand.

8 Share with students the materials you have provided for designing and making prototype packaging for their products.

9 Ask students to present drawings/prototypes to class and explain the reasoning for their design.

Extended Learning

1 Have students write to and send their designs/prototypes to packaging manufacturers as suggestions for improvement in package design.

2 Analyzing a variety of products, measure the actual amount of the product compared to the size and shape of the product's package.

3 Invite representatives from the grocery business and the packaging industry to class to discuss packaging.

4 Research the regulatory standards packagers and retail outlets are required to meet. **Ask:** "Who sets these standards? Why are they required?"

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Packaging Information Sheet

Consumers need to consider the role packaging plays from point of production to retail market in order to understand the importance of packaging's development, design, and function. Consumers also need to understand that packaging contributes significantly to our society's volume of waste.

Function and Benefits

- Preservation and protection of contents
- Sanitation and safety, protection of public health
- Identification of product
- Prevention of theft
- Providing instruction as to product use
- Compliance with regulatory standards
- Manufacturing of packaging provides employment
- Increased profits

Drawbacks

- In industrial countries, packaging contributes about 30 percent of the weight and 50 percent of the volume of household waste.[2]
- Without reuse or recycling, the energy and natural resources that go into packaging are lost forever in landfills.
- Packaging contributes significantly to litter. Litter degrades the health and beauty of nature.
- Packaging may create false impressions about the amount or quality of products.
- Increased cost to consumers.

2 Cynthia Pollack-Shea, "Realizing Recycling's Potential," State of the World 1987, New York, NY: W.W. Norton and Company, 1987, p. 103.

Packaged Products Worksheet

Cosmetics/Drugs

lipstick - in paper/plastic
aspirin - in plastic jar/paper box
shampoo - in plastic bottle
toothpaste -in plastic tube/paper box

Fresh Produce

tomatoes - in paper or plastic
potatoes - in paper or plastic sacks
mixed sprouts - in plastic

Canned Foods

green beans - in tinned can
vegetables - in glass jar

Household Products

laundry soap - in recycled paperboard box
cleansing powder - in paper/metal can
furniture polish - in glass bottle

Frozen Foods

vegetables - in paper cartons
vegetables - in plastic bag
ice cream - in plastic tub
TV dinner - in aluminum tray

Dried Foods

cereal - in recycled paperboard box
spaghetti - in plastic

Refrigerated Perishable Foods

fresh meat - in plastic tray/wrap
milk - in plastic jug
milk - in paper cartons
eggs - in styrofoam carton
eggs - in recycled paper carton

Drink Containers

juice - in paper boxes in plastic pack
juice - in plastic six pack - aluminum/plastic serving packs
juice - in tinned cans
juice - in glass bottle or jar
juice - in aluminum can
juice - in paper/metal can

You're Eating More Energy Than You Think!

Subjects: Home Economics, Math
Grades: 10-12
Teaching Time: One Class Period
Focus: Energy, Conservation, Environmental Impact, Product Packaging, Recycling

Rationale

Every product we make or use has "hidden" energy and environmental costs.

Learning Objective

Students will:

- Understand that different forms of packaging require different amounts of energy.
- Learn that food containers differ in their environmental/energy impact.

Teacher Background

The unit of heat energy used in science is the calorie (cal.), also called gram-calorie or small calorie. It is defined as the amount of heat energy needed to raise one gram of water 1° Centigrade.

In nutrition, the unit of food energy is the Calorie (Cal.), also called kilogram-calorie, or great calorie. It is defined as the amount of heat energy needed to raise one kilogram of water 1° Centigrade. It is equal to 1,000 calories.

The small c, capital C difference is important. Only the nutritional calorie uses capital C.

Engineers use a different heat energy standard called the British thermal unit (BTU). It is defined as the quantity of heat required to raise one pound of water 1° Fahrenheit. One BTU = 252 calories.

*** EXTRA NOTES:**

1 pound = 454 grams
°C = 5/9 (°F - 32)
1 kilogram = 2.2 pounds

Environmental Benefits of Recycling

Environmental Benefit	Aluminum	Steel	Paper	Glass
Energy Use Reduction	90-97%	47-74%	23-74%	4-32%
Air Pollution Reduction	95%	85%	74%	20%
Water Pollution Reduction	97%	87%	35%	—
Mining Wastes Reduction	—	—	—	80%
Water Use Reduction	—	40%	58%	50%

Source: Robert Cowles Letcher and Mary T. Sheil, "Source Separation and Citizen Recycling, " in William D. Robinson, ed. The Solid Waste Handbook, New York, N.Y.: John Wiley & Sons, 1986

Materials

- Charts "Energy Used By Packaging Materials" and "Environmental Benefits of Recycling"

Pre & Post Test Questions

1. What are some different types of packaging commonly used for your favorite foods?

2. Which packaging material uses the most energy to produce? The least?

3. How can we, as careful consumers, reduce waste and the use of energy and resources, while promoting reuse and recycling?

Learning Procedure

1 Using information from the chart "Energy Used By Packaging Materials," determine and compare the energy necessary to package the sample foods.

2 Fill in the price (current value) of the foods and compare the prices with the amounts of energy required.

3 Determine the types and amounts of energy required by the individual containers. Where necessary, divide the energy per pound by the correct weight of the container being examined.

4 By referring to the chart, "Environmental Benefits of Recycling," discuss the environmental impacts of container manufacturing and disposal. **Ask:** "What are some advantages of recycling as compared to disposal in a landfill?" (saves disposal costs, conserves energy, conserves nonrenewable natural resources)

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Energy Used by Packaging Materials

Material	*kcal/lb.	*kcal/oz.	*kcal/gm	BTUs/lb	BTUs/gm
Paper	5,134	321	11.4	20,373	44.9
Glass	1,918	120	4.2	7,611	16.8
Steel	3,724	233	8.3	14,778	32.6
Aluminum	24,837	1,552	54.7	98,560	217.1
Plastic	4,670	292	10.3	18,532	40.8

Energy Used by Packaging Materials

Food	Amount by Weight	Energy for Container (kcal.)	Today's Price ($)
Fresh Potatoes			
Canned Potatoes			
Frozen Potatoes (Hashbrowns)			
Potato Chips			
Dehydrated Potatoes			

*Kcal: 1 kilocalorie = 1 Calorie

I Don't Need A Bag

Subjects: Art, Math, Home Economics
Grades: 4-9
Teaching Time: 30 Minutes
Focus: Waste Reduction, Reuse

Rationale

Food containers and packaging consume energy and are major components of solid waste. Containers and packaging in the United States municipal waste stream increased (after recycling) from 24 million tons in 1960 to 47.6 million tons in 1993.[1] Containers and packaging were 29.5 percent of the total discards in 1960, and were 29.4 percent of total discards in 1993.[2]

Learning Objective

Students will:

- Learn the energy savings value of reusing grocery bags.
- Calculate how many BTUs would be saved in a year by using their own reusable grocery bags.

Materials

- A paper grocery bag and one plastic grocery bag
- A lightweight scale or a given weight for an average sized grocery bag

Pre & Post Test Questions

1. How many grocery bags does your family use in a week? In a year?

2. Which type of grocery bags, paper or plastic, are easier to recycle?

3. What Pacific Northwest jobs are influenced by using paper or plastic grocery bags?

4. How many ways can you recycle or reuse grocery bags?

5. Do you use paper or plastic grocery bags?

Learning Procedure

1 Discuss reasons for carrying groceries home from the store in a reusable bag.

2 Have each student figure out how many paper sacks his or her family uses in a year. Calculate approximately how many BTUs would be saved in a year if each family brought its own shopping bag. NOTE: Packaging paper takes 44.9 BTUs/g to make and packaging plastics take 40.8 BTUs/g to make.

3 Point out to students that some grocery stores give small credits to customers who reuse grocery bags.
Ask: "Does your store give this credit?"

4 In Home Economics class, discuss different possibilities for shopping bag design and decoration.

5 Discuss the pros and cons of plastic versus paper grocery bags.

Extended Learning

Using a detailed city map, pin mark the location of those grocery stores in your area that give a small cash credit for reusing grocery bags.

1 EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update,
2 Ibid.

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Commercials With An Environmental Message

Subjects: English, Speech, Social Studies
Grades: 5-12
Teaching Time: Two 30-Minute Periods With Follow-Up
Focus: Waste Reduction, Consumer Awareness

Rationale

Many products, in addition to being desirable or useful to the consumer, have an impact on the environment. These effects on the environment may not normally be considered by advertisers or purchasers.

Learning Objective

Students will:

- Learn that commercials can be brief, entertaining, and promotional and still take into consideration the environmental consequences of a product. This understanding encourages students to take these environmental impacts into consideration when buying.

Teacher Background

Nearly $1 out of every $10 spent for food and beverages in the United States pays for packaging.[1]

In industrial countries, packaging contributes about 30 percent of the weight and 50 percent of the volume of household waste.[2]

Pre & Post Test Question

Why should we consider the problem of disposal before we purchase a product?

Learning Procedure

Students will revise a current commercial or write a commercial for a new product that is brief, entertaining, and promotional and presents the environmental consequences of a product. This will be performed before the class as a skit. (Videotape and play back if you have access to equipment.)

1 Notify students of the assignment and allow several days for them to view TV commercials, noting any references to environmental impacts of the products advertised.

2 Have students discuss five advertisements in detail, explaining how the commercials could have been changed to include positive environmental impacts. If a product does not have a positive environmental impact, have students create a new product.

3 Have students create a political ad highlighting a candidate's reactions or campaign promises about landfills, waste burners, recycling, etc.

4 Allow sufficient time for students to write their commercials containing environmental messages.

5 Have students present their commercials, including use of props, cue cards, etc. (Note: If commercials are to be videotaped, the teacher may want to allow extra time for students to feel at ease in front of the camera.)

Examples:

Juice in cardboard boxes versus juice in aluminum cans; returnable, refillable bottles versus nonreturnable, nonrefillable bottles; glass bottles versus plastic bottles.

1 Cynthia Pollack-Shea, "Realizing Recycling's Potential," State of the World 1987, New York, N.Y.: W. W. Norton, 1987, p. 103.
2 Ibid.

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Take A Bite Of The Finite

Subjects: Social Studies, Math, Science
Grades: 6-12
Teaching Time: 45 Minutes
Focus: Conservation of Resources, Nonrenewable Resources

Rationale

The earth contains a finite supply of mineral resources. Wasting resources - using them only once and not recycling - shortens the time these resources will be available. As countries become more industrialized, affluent, and developed, they consume and waste more finite resources.

Color	Beads	Finite Resource	1996 Estimates of Global Reserve Base*
Red	416	Iron in ore	100 billion metric tons
Blue	104	Bauxite	28 billion metric dry tons
Yellow	1	Tin	10 million metric tons
Silver coin	1	Silver	420,000 metric tons
Green	3	Copper	610 million metric tons
Orange	1	Lead	120 million metric tons
Purple	28	Chromium	7.4 billion metric tons
Coin	1	Platinum	66,000 metric tons
Black	20	Oil	708 billion barrels**

*"The reserve base includes those resources that are currently economic (reserves), marginally economic (marginal reserves), and some of those that are currently subeconomic (subeconomic resources)." U.S. Bureau of Mines, Mineral Commodities Summaries: 1996 Summaries, Washington, D.C.: U.S. Government Printing Office, 1996.

**Oil reserves source: Lester R. Brown and Sandra Postel, "Thresholds of Change," State of the World 1987, New York, N.Y.: W.W. Norton, 1987, p. 12.

Metric ton = 2,200 lbs. Short ton = 2,000 lbs.
Troy ounces x .0685 = lbs. 32,150.7 troy ounces = 1 metric ton (1,000 kilograms)

NOTE: The number of beads reflects a mineral's relative, estimated total abundance, not the ease of extraction or potential availability of that mineral. The beads are not distributed in exact percentages, to allow for hypothetical and undiscovered resources.

Learning Objective

Students will:

- Understand that some resources, including resources lost to waste disposal, are finite.

Materials

- Colored beads (see chart)

Learning Procedure

Version One

1 Select beads of different colors to represent resources that often end up as wastes.

2 Hide beads and coins throughout the classroom and have students divide into teams representing countries. (Make sure some of the beads are hidden so well they will not be immediately found.)

3 Give teams time intervals of two minutes and one minute to explore for resources.

- After exploration, students are to separate and identify the mineral represented by each color of bead.
- Discuss the greater difficulty in finding resources during the second exploration.
- Discuss what is required to explore for and obtain resources (among other things, energy). **Ask**: "Is energy a renewable or nonrenewable resource?"
- "What is happening to the world population? What effect will rapid population growth have on the future availability of nonrenewable natural resources?"
- "Is competition for resources emerging among countries?" Think of examples.
- After exploring, have students jumble the resources together. **Ask:** "What is this jumble of resources like?" (A dump) "What did it take to get these resources into a usable condition in the first place?" (Energy, refining/separation?) "What is necessary to keep these resources in the cycle of use?" (Separation and recycling?)

For older students:

"What is entropy?" "Why is jumbling resources together and throwing them away an example of entropy?" "What is the Second Law of Thermodynamics?" "How is wastefulness related to the Second Law?"

4 "What can you do to extend the life of finite resources?" "What are the advantages of extending the life of these resources?"

Version Two

1 Hide beads throughout the room, keeping some colors in large groups to represent concentrated ore deposits. Hide some beads very well. Also hide one or two differently colored beads to represent rare strategic metals such as chromium and platinum. Divide students into countries: two large industrialized countries (such as the United States and Canada), two small industrialized countries (such as Japan and Sweden), four developing - Third World - countries (such as Brazil, India, Zimbabwe, Guinea). The number of countries can be changed, but the relative numbers should be kept the same. The idea is to reflect the world's unequal distribution of population and resources.

2 Have students consider the implication of the fact that some rare strategic minerals are found in countries controlled by hostile or repressive governments.

3 Have students explore the possibilities of what to do about local and future shortages of resources. Possible solutions include: recycling, conservation, trading, and treaties.

4 Given the ideas outlined in this activity, have students develop their own learning activity or game (e.g., Risk).

5 Consider extending this activity by adding money to buy resources, setting up cooperative ventures between countries, forming resource cartels, etc. ("An enterprising teacher could take this game as far as imagination and time allows.") Mike Harves, Davis High School, Yakima, Washington.

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Nonrenewable Resources: How Long Will They Last?

Subjects: English, Social Studies (Geography, Contemporary Problems)
Grades: 7-12
Teaching Time: 45 Minutes
Focus: Nonrenewable Resources, Recycling

Rationale

There is a limit to how long more and more of us can continue to make increasing demands on our finite resources. Concentrated, easily mined reserves of nonrenewable resources are being depleted. The availability of these resources can be extended by careful use and recycling. (Note: This activity highlights nonrenewable natural resources other than the fossil fuels.)

Learning Objective

Students will:

- Learn the estimated life expectancies of selected nonrenewable natural resources.
- Understand the role recycling plays in meeting the demand for certain nonrenewable resources.
- Understand the role careful use might play in extending the availability of selected natural resources.

Teacher Background

"The global demand for and consumption of most major nonfuel mineral commodities is projected to increase 3-5 percent annually, slightly more than doubling by 2000."[1]

Pre & Post Test Questions

1. What metal comes from bauxite?
2. What is a mineral deposit?
3. Define total resources.
4. Define nonrenewable resource.
5. Name ten nonrenewable resources.
6. What does "reserve base" mean?

Learning Procedure

Examine the chart "Selected Nonrenewable Natural Resources: Their Life Expectancies and Prime Consumers."

1 Which column under the heading "Life Expectancy (in years)" do you think is more accurate in estimating the length of time our nonrenewable natural resources will last? What are some factors leading to the accelerated use of resources?

2 Examine the "static use" column under the heading "Life Expectancy (in years)." Which nonrenewable natural resource will be used up first?

Ask: "Which countries have the highest reserves of the resource?" Locate these countries on a world map.

Ask: "Why does the U.S. need to be concerned with the depletion of this resource?"

3 "Which nonrenewable resource will last the longest according to the static index? According to the projected rates index?"

1 Council on Environmental Quality, Global 2000 Report to the President: Entering the 21st Century. Vol. 1: Summary. Washington, D.C.: U.S. Gov't Printing Office, 1982.

Ask: "Which countries have the highest reserves of this resource?"

Ask: "With which countries will the U.S. need to cooperate in order to get the amount of this resource it needs?"

4 "Which resource is most extensively recycled?" List items you use that contain this resource. "Which of these items could you recycle?"

5 List the resources that will probably be used up within the next 40 years, given projected use rates. **Ask:** "What role do recycling and careful use play in extending the availability of these resources?"

The following graph illustrates three possible depletion patterns for a nonrenewable natural resource. Pattern a shows that a rapidly expanding use of a resource without improved mining technology and increased recycling will lead to exhaustion of available quantities of that resource. Patterns b and c illustrate that this rapid rate of depletion can be significantly slowed by improved mining technology that can exploit less concentrated mineral deposits, by reduced per capita use, and by increased recycling.

"How can we determine how long a given resource might last?" Any projections are based on two major sets of assumptions: We must estimate the potentially available supply at existing (or future) acceptable prices and with existing (or improved) technology, and we must estimate the annual rate at which the resource may be used.

"There is no danger whatever of humanity 'running out' of nonfuel mineral resources, and I have not said there is. Humanity is not destroying them. What will run out, however, is the capacity of the environment to absorb the punishment associated with mining ever-lower grades of ore or reconcentrating what is already dispersed. Secondarily, the ability to do the job at an attractive cost will also 'run out'."[2]

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2 Paul Erlich Social Science Quarterly March 1981, Vol. 62, No. 1.

Selected Nonrenewable Natural Resources; Their Life Expectancies and Prime Consumers

Resource	A. 1996 World Estimates of Reserves*	B. Countries or Areas with Highest Reserves		C. Percent of Imports in U.S. Consumption 1995	D. Life Expectancy as of 1989 (in years)		E. Amount Recycled Worldwide 1995
					Static Use at 1976 Level	Use Growing at Projected Rates	
Aluminum in Bauxite	23,000,000 thousand metric dry tons	Guinea Australia Brazil	24% 24% 12%	99%	312	63	No bauxite recycled. In the U.S., 50% of all aluminum cans were recycled.
Chromium	3,700,000 thousand metric tons	Rep. of S. Africa Kazakstan	84% 9%	78%			Chromium contained in purchased stainless steel scrap accounted for 22% of demand.
Copper	310,000 thousand metric tons	Chile European & Asian Markets U.S.A.	28% 18% 15%	6%	63	36	Old scrap - 460,000 tons or 18% of consumption. New scrap - 850,000 tons
Gold	44,000 metric tons	Rep. of S. Africa European & Asian Markets U.S.A.	41% 21% 12%	net exporter			150 metric tons, including new and old scrap.
Iron in Ore	65 billion metric tons	U.S.S.R. Australia Brazil	37% 15% 10%	18%	172	62	There is no significant recycling of iron ore.
Lead	68,000 thousand metric tons	Misc. Countries Australia U.S.A.	35% 28% 12%	15%	172	25	Recovery of lead from scrap batteries - 825,000 tons.
Platinum Group Metals	56,000 metric tons	Rep. of S. Africa Russia	89% 11%	N/A			Recovery of about 60 metric tons, including new and old scrap.
Silver	280,000 metric tons	European & Asian Markets Canada Mexico	43% 13% 13%	N/A	20	17	About 2,000 metric tons recovered.
Tin	7,000,000 metric tons	China Malaysia Brazil	17% 23% 17%	84%	41	31	Old and new scrap - 12,000 tons. 17% of tin in U.S. was recycled.

* Reserves is the part of the reserve base that can be economically extracted or produced.

N/A = Not Available.

Sources: Columns A, B, & C - U.S. Bureau of Mines, 1996 Mineral Commodities
Column D - Global 2000 Report
Column E - U.S. Bureau of Mines, 1996 Mineral Commodities

Nurture Some Nature

Subjects: Social Studies, Language Arts, Art
Grades: K-3
Teaching Time: Two 20-Minute Periods
Focus: Litter Abatement

Rationale

Any change in attitude or behavior toward litter begins with an awareness and knowledge of the problem.

Learning Objective

Students will:

- By keeping an area free of litter, become aware of their responsibility and ability to solve the problem of litter.

Materials

- Litter bags
- Art supplies

Teacher Background

Litter is "waste out of place." Washington State fresh litter samples in 1987 numbered 344 items per mile per week.[1]

Read "My Twenty Foot Swath," p. 172, for information on litter control.

Pre & Post Test Questions

1. What is litter?

2. How can we reduce litter?

Learning Procedures

1 Instruct students to pick up one piece of litter on the way to school. Hold it up in front of class. **Ask:** "What can you tell about litter from what we have gathered?" "What kinds of things commonly end up as litter?" "Why do these things end up as litter?" Have students define what waste category each litter item falls into (i.e., glass, paper, aluminum, etc.). List on chalkboard.

2 Ask students about their thoughts on litter. What they feel about litter, who litters, when, and why. "Are there any dangers associated with litter?" "Are there fines?"

3 Discuss facts about litter and recycling from the Solid Waste Fact Sheets, p. 83.

4 Divide the class into teams, giving each a litter bag. Conduct a five-minute litter hunt contest on the school grounds. Use a whistle or some other method to signal the end of the hunt.

5 Gather students into a circle or return to the classroom to see which team picked up the most litter. Have awards for quantity, volume, or weight. Have students decide if they found anything that could be recycled.

6 Complete one of the student projects using the collected litter:

- Drama — Select a piece of litter. Use it to act out a scene telling its history. Start with the components of the object and trace their history up to the point at which the article is discarded.
- Creative Writing ---- Do the same assignment in written form.
- Cartoon ---- Draw a picture story about litter.
- Poster ---- Use a piece of litter as part of an anti litter poster for the school.
- Showcase ---- Use the litter to create an anti-litter showcase or bulletin board for the school or classroom.
- Sculpture — Create a three-dimensional form with litter and display with the poster at the entrance to school.

1 Daniel B. Syrek, Washington Litter 1987, Sacramento, Institute for Applied Research, 1987, p. 8.

Resources - *Video Tapes:* In The Bag. *Walt Disney Educational Media, Coronet Films. 8 min.*
The Litterbug. Walt Disney Educational Media, Coronet Films. 8 min.

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Would You Do It If I Taught You? If I Paid You?

Subjects: Social Studies, Economics, Business, Environmental Studies

Grades: 3-12

Teaching Time: Three Weeks, Plus Conclusion

Focus: Recycling for Profit, Litter Reduction, Ethics and Economics of Recycling

Rationale

Education and a sense of responsibility for the health of the the environment will increase recycling, but immediate financial reward is also a powerful catalyst to action.

Learning Objective

Students will:

- Understand that financial reward —– the profit motive —– plays an indispensable role in making recycling happen.

Teacher Background

Markets for recyclables may determine if an item is recycled or incinerated and/or landfilled. Currently recyclers pay abount $15 a ton for newspapers in Washington. Some items are not always accepted for recycling now because of depressed markets.

The 1995 crew of the Washington State Ecology Youth Corps cleaned 2,552 miles of highways and collected 156 tons of litter. The Corps recycled 4.2 tons of aluminum cans, 2.4 tons of scrap metal, 5.8 tons of bottles and glass, and 1.7 tons of plastic and cardboard. Another 22.6 tons of litter were collected from state parks, rest areas and other sites.[1]

In 1994, Washington State generated about 7.5 million tons of solid waste. Washington State residents recycled 38% of the recyclable solid waste stream.[2] For further information on litter and recycling facts, see the Solid Waste Fact Sheets, p. 83.

Materials

- 1 large litter basket/newspaper recycling container
- Scale to weigh collected litter and newspaper.

Pre & Post Test Questions

1. What is the best way to motivate people not to litter and to recycle?

2. How much litter was picked up along freeways and highways in 1995.

3. Who picked it up? (Department of Ecology Youth Corps)

1 Washington State Department of Ecology, Solid Waste in Washington State, Publication # 96-500, Feb. 1996, p. 33.
2 Ibid., p. 53.

4. How much Washington municipal solid waste was reported in 1994?

5. How much was recycled?

Learning Procedure

1 Week 1. Without any prior discussion about the problems caused by litter and other solid waste, ask students to bring in litter or recyclable newspaper from outside the classroom to put in the litter or recycling basket. Stress that the litter or newspapers should not be raided from household or school trash cans. At the end of one week, weigh the collected litter and newspapers. Empty the containers and use them for Week 2.

2 Week 2. Do litter or paper recycling lessons appropriate to grade level e.g., "Nurture Some Nature," p. 121; Take A Look In Your Garbage Can!" p. 129, and "Paper From The Urban Forest," p. 143. Encourage students to act on what they've learned in these lessons by picking up litter or recycling newspaper for placement in the cans. At the end of the second week, weigh the cans again and save containers for Week 3.
What effect did education have on the amount of litter collected?

3 Week 3. Say something like "You've been doing a pretty good job bringing in litter, but I'm still noticing litter around the school and in the neighborhood, so I am going to give a reward if you pick up even more litter and things look a lot cleaner by the end of next week. I will also reward you if you bring in newspaper for recycling." Rewards might be: free time, an extra recess, story reading, money, snacks, party time, etc. At the end of the third week, again weigh the collected litter and newspaper. Give rewards, if earned.

4 Put the information from the three weeks on the chalkboard or overhead.
Ask: "What were the differences between the weeks in terms of the amount of trash collected or newspaper recycled?" "Other differences?" "During which week was the most litter and newspaper collected?" "The least?" "Why?" "Why was there a change between weeks?"

Ask: "Which would give best results?":

- Asking someone to do something (pick up litter or recycle).
- Giving reasons why and asking someone to do something.
- Giving reasons why and rewarding someone for doing something.

5 Discuss why people operate recycling centers.

6 Discuss what would happen if recyclers were not rewarded (paid). "Would others save things to be recycled?" "Why or why not?"

Extended Learning

Invite a representative from the recycling industry to visit your class and explain his/her business. Ask the recycler how many recyclables he/she handles, how much he/she pays, and how he/she makes money. Ask how your class or school might begin recycling. Begin a recycling program in your school.

Results -- Pounds Collected

Week	Motivation	Litter	Recycling
1	Request		
2	Education		
3	Reward		

Resources - *Video Tape.* PSAs*. (Public service announcements). Washington State Department of Ecology. 3 min., color.*

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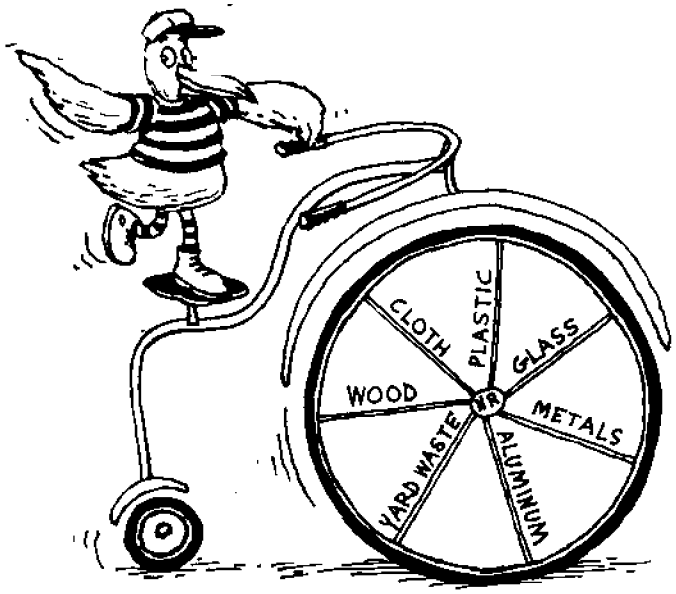
Recycle Bicycle

Subjects: Social Studies, Language Arts, Art
Grades: K-6
Teaching Time: 15 to 30 Minutes
Focus: Cycles, Recycling, Natural Resources



Rationale

To be motivated to recycle at home, students must understand the basic idea of recycling.

Learning Objective

Students will:

- Understand the roles recycling and individuals play in extending the life of resources.

Materials

- Glass bottle
- Plastic bag
- Newspaper/paper bag
- "Tinned" can
- Aluminum can

Pre & Post Test Questions

1. How are a circle and a cycle alike?
2. What are natural resources? Name three.
3. What is a cycle?
4. Why should we recycle?
5. Name three materials you could recycle.
6. Demonstrate a cycle with four or more stages.
7. What is a natural resource?

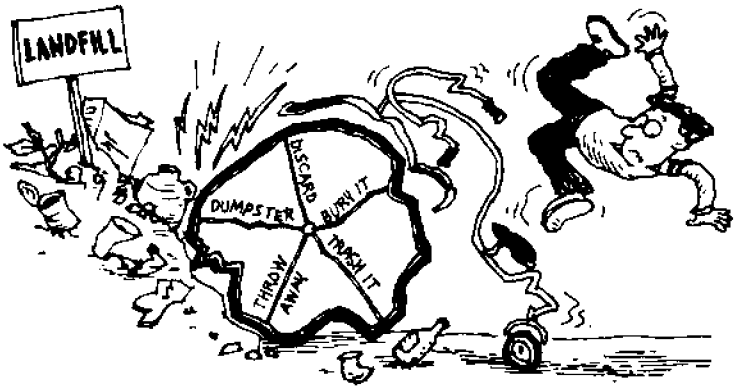
Learning Procedure

1 (Grades K-2) Draw a circle on the board in segments. Describe how it is continuous.

2 Discuss cycles including natural cycles such as the oceans - evaporation - rainwater cycle, or spring - summer - fall - winter.

3 Write the word "recycle" on the board and draw a large bicycle wheel with spokes. Write the word "bicycle" next to it and ask the children how the two words are alike. Discuss what cycles are in general, and how this concept applies to garbage.

4 List some of the things students commonly throw away at home. Bring in examples of paper, metal,



plastic, etc. Identify categories into which this waste can be grouped.

5 Label each spoke of the recycling wheel with one of these category headings. Discuss the original source of all these products and label the hub of the wheel "natural resources."

6 **Ask:** "What do you do with items from these categories once you have used them at home?" Draw a person on the rim to show that the individual has a choice to either keep the material in the cycle of use or discard the waste in a landfill where the resources and energy that it is made of are lost forever.

7 (Grades 4-6) Hold up each item and ask what natural resource is used to make that item (e.g., plastic - petroleum, newspaper - tree). Write the paired words on the board. Have the class write out all the steps in the manufacturing cycle of one of the items.

Extended Learning

(Grades 4-6) Have class members write a short paper or make an oral presentation with artwork or visual aids (photos, slides, acting) of the complete cycle of a natural resource (e.g., bauxite to aluminum to a can to the landfill or recycling center). Point out the importance of continuing the cycle for energy savings and waste reduction when you recycle.

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Washington State Department of Ecology. A Guide to Recycling Around the House. Olympia: Office of Waste Reduction, Recycling and Litter Control, 1989.

Take A Look In Your Garbage Can!

Subjects: Social Studies, Science, Math, Art
Grades: K-6
Teaching Time: 45 Minutes
Focus: Waste Reduction, Reuse, Recycling

Rationale

The average family garbage can contains predictable types and amounts of waste. Much of this waste is unnecessary; some is reusable and recyclable.

Learning Objective

Students will learn:

- What the average family of four throws away every day.
- What steps can be taken to reduce the amount of garbage a family generates by reusing and recycling.

Teacher Background

The average person in Washington State disposed of 5.2 pounds of daily household waste in 1994.[1] The waste stream for each employee in a restaurant in Washington State is 10 pounds per day.[2] Each student in Washington State generated about 118 pounds of waste in the 1992 school year.[3] The municipal waste stream before recycling, according to national figures, is 4.4 pounds daily of solid waste per person.[4] Study the categories of solid waste on p. 83.

Materials

- Heavy cardboard or construction paper
- Colored marking pens
- Garbage can poster/silhouette
- Masking tape, Scotch tape, or Velcro
- Scissors
- Tape measure (if you build a scale model)

Pre & Post Test Questions

1. When we fill up the garbage can, what percentage is glass? paper? metal? plastic? yard and food waste?

2. What can we do to reduce the amount of garbage we throw away?

3. What materials can be separated from our garbage and be reused or recycled?

4. What materials will a recycler pay for?

5. What is waste reduction? (see Glossary)

6. How much money a week do you pay to have your garbage picked up?

7. What happens to the garbage after it is picked up?

Learning Procedure

In this section, you will show students what is in the average family garbage can according to weight. The cans have seven categories: paper, metal, glass, plastic, yard waste, food waste, and other. Cut out seven strips of cardboard or paper for the seven solid waste categories.

1 Construct a garbage can out of cardboard, construction paper or poster board, or draw a garbage can on the chalkboard. (See diagram, p. 83

1 Washington State Department of Ecology , Solid Waste in Washington State, Publ. # 96-500, Feb. 1996, p. viii.
2 Ibid. 1992 Washington State Waste Characterization Study, Vol 1: Executive Summary , July 1993, p. II-4.
3 Ibid.
4 EPA., Characterization of Municipal Solid Waste in the United States, 1994 Update, p. 3.

For comparison, you may construct two garbage cans: one for the U.S. and one for Washington State.

2 Ask students to make a list of ten items that are in the class's garbage cans.

3 Outline for the class the seven categories of household solid waste. Have the students list their ten items under the seven solid waste categories.

4 Place the seven pieces of cardboard face down on a table and have a student choose a card. (You may wish to leave the cards for yard and food waste separate.) Have the student read what is on the card. (For younger students, the teacher may show the cards to the students or even draw a picture representation of the item.)

5 Have the class tell which items from their list fit the category of each card as it is displayed. Have them guess what percentage of the total is included in the category displayed. (You may wish to compare state and national figures, or list the percentages and have students guess which percentage fits each category.)

6 As you place a strip "in" the garbage can, discuss the following facts for each category. (You may want to predetermine the order of presentation of the cards. If you are using a chalkboard, you may draw a horizontal line across the garbage can drawing and write in the category and its percentage.)

A. Paper

In 1992:

- In Washington State, 29 percent of all waste materials came from paper,[5] whereas approximately 37 percent of the national solid waste stream was paper.[6]
- The U.S. recovered 34 percent of all paper products produced in 1993.[7]
- Washington residents recycled 74 percent of their corrugated paper; 62 percent of their high-grade paper; 74 percent of their newspapers.[8]

Ask: "What are some of the things we throw away that are paper?"

- Cereal boxes (If the inside of the box is gray, it was probably made from recycled newspaper.)
- Newspapers
- Magazines
- Letters
- Cardboard boxes

B. Glass

- Seven percent of the U.S. solid waste stream is glass.[9] In Washington State, 5 percent of the solid waste stream is glass.[10]
- Glass does not degrade for hundreds, perhaps thousands of years. However, glass can be crushed into particles (called cullet), reheated, and reformed into glass products at an energy savings of 4 to 32 percent compared with glass made from virgin products.[11]

Ask: "What do you throw away that is made of glass?"

- Food jars
- Beverage containers
- Ornamental glass
- Household cleaners

C. Metals

- Ferrous metals such as iron and steel represented about 6.2 percent of the U.S. solid waste stream in 1993.[12]

5 Ecology, 1992 Washington State Waste Characterization Study, Vol. 1: p. II-27.
6 EPA, Characterization of Municipal Solid Waste, p. 29.
7 Ibid, p. 30
8 Ecology, Solid Waste in Washington State, p. 39.
9 EPA, Characterization of Municipal Solid Waste, p. 29.
10 Ecology, 1992 Washington State Waste Characterization Study, Vol. 1: p. II-27.
11 Cynthia Pollock-Shea, "Realizing Recycling's Potential," State of the World 1987, New York, N.Y.: W.W. Norton, 1987, p. 109.

- Aluminum represents approximately another 1.5 percent of the metals in garbage.[13] Other nonferrous metals such as copper and brass make up a very small share of the U.S. waste stream. The total waste stream content for metals is approximately 8 percent.[14]
- Thirty-five percent of the aluminum manufactured in the U.S. is recycled. The national rate for all metals is 30 percent.[15]
- Seven percent of Washington State's waste stream is metal, 1 percent of which is aluminum.[16]

Ask: "Why is the recycling rate so high for aluminum?" "Do you recycle aluminum?"

What other metal items are found in garbage?

- "Tinned" food cans
- Metal caps from jars and bottles
- Automobile parts

Interesting fact: The tin in a "tinned" can is a thin layer comprising only 1 percent of the can.

D. Plastic

- Ten percent of what Washington State residents throw away is plastic.[17] Nationally, approximately 9 percent of the municipal solid waste stream is plastic.[18]

2. At least 46 different types of plastic polymers are used in products bought by U.S. consumers.[19] Interesting fact: To make a squeezable plastic ketchup bottle, six different layers of plastics are used. Each layer does a different job; such as give the bottle strength, flexibility, shape, and impermeability.[20]

E. Others

- Other miscellaneous solid waste stream items such as textiles, wood, rubber, leather, and inorganics comprise 8 percent of the Washington State waste stream. Construction debris is 17% of our waste stream.[21]
- On a national scale, these same items are 15 percent of the total solid waste stream.[22]

Examples of other items are:

- Rubber tires
- Clothing
- Toys (wooden)
- Tennis shoes

F. Compostables

Compostable items, which include yard and garden wastes as well as food wastes in the home, comprise 24 percent of the waste stream in Washington State[23] and 29 percent of the U.S. waste stream.[24]

7 Discuss how we can reduce the amount of garbage in our homes. (recycling and reduction)

Reduction is the process of buying only necessary items, or items that have little packaging, or buying items in recyclable containers.

12 EPA, Characterization of Municipal Solid Waste, p. 29.
13 Ibid.
14 Ibid.
15 Ibid., p. 30.
16 Ecology 1992 Washington State Waste Characterization Study, Vol. 1: p. II-27.
17 Ibid.
18 EPA, Characterization of Municipal Solid Waste, p. 29.
19 Pollock-Shea, "Potential," p. 104.
20 Pollock-Shea, "Potential," p. 104.
21 Ecology, 1992 Washington State Waste Characterization Study, Vol. 1: p. II-27.
22 EPA, Characterization of Municipal Solid Waste, p. 29.
23 Ecology, 1992 Washington State Waste Characterization Study, Vol. 1: p. II-27.
24 EPA, Characterization of Municipal Solid Waste, p. 29.

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Ibid. 1992 Washington State Waste Characterization Study, Vol. 1-6, July 1993.

Cooperative Problem Solving For The Environment

Subjects: Contemporary Problems, English, Social Studies, Science

Grades: 6-12

Teaching Time: Four or Five Class Periods.

Focus: Brainstorming, Problem Solving Process, Recycling

Rationale

Once students have been made aware of a problem, they need techniques and skills to solve that problem.

Learning Objective

Students will:

- Learn a cooperative problem solving process designed to increase recycling.
- Know how to brainstorm.
- Learn who can recycle.

Materials

Student Handouts

- # 1 ---- Segments of Society to Involve in Recycling
- # 2 ---- Problem Solving Process
- # 3 ---- Creating Ideas

Evaluation chart

Fact sheet (in Handout 2)

The handouts may also be presented as overheads or displayed on the board.)

Teacher Background

Review the information about our nation's waste crisis in the Solid Waste Fact Sheets, p. 83.

Pre & Post Test Questions

1. Describe a problem-solving technique we could use to increase recycling.

2. Who is responsible for solving our waste disposal problem? Which segments of society need to be involved in the solution?

3. How do we determine if a suggested incentive to increase recycling is a good one?

4. What is the purpose of a task force?

Learning Procedure

1 Discuss the waste crisis in our state and country with your class. Review with them the information from the Teacher Background and facts that accompany this activity. For example, Washingtonians produced 5,123,185 tons of solid waste in 1994. Of this amount about 38 percent was recycled. The almost four million tons remaining cause environmental, economic, and political problems.[1]

Nationally, each American produces about 1,241 pounds of garbage a year.[2] In Washington State each person produces about 1,000 pounds of residential garbage per year.[3]

Another good way to focus on the our waste dilemma is for students to keep an environmental journal cataloging all radio, television, and newspaper stories about waste for five days.

1 Washington State Department of Ecology, Solid Waste in Washington State, Feb. 1996, p. viii.
2 EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update, P3.
3 Washington State Department of Ecology, Solid Waste in Washington State, p.54.

2 Have students complete Handout # 1, being as specific and complete as possible.

3 Using Handout # 2 as a guide, review the following problem-solving processes:

1. Understand the problem
2. Brainstorm: Use Handout # 3 as a guide to brainstorming.
3. Analyze
4. Elaborate
5. Evaluate
6. Select the best solution

4 Divide students into groups of four. Each group is a State Recycling Task Force. Assign roles to Task Force members: recorder, discussion leader, spokesperson.

5 Tell students they have been asked by the Governor to serve on a Recycling Task Force to recommend ways to increase recycling in Washington.
Ask students to come up with solutions using the process defined in Handout # 2.

6 Time to select your best idea. Which idea for increasing recycling received the highest score? Do you think this is the best answer or do you want to combine two of your highest ranking incentives? Elaborate your best solution. Describe it clearly. Would graphs, charts, or time lines help?

7 Now present your plan to your class.
Ask for questions and comments and note ways your proposal could be improved.

Extended Learning

1 After individual groups have presented their best solutions, have the class develop evaluative criteria and come up with a class solution.

2 Invite a recycling representative to class to help evaluate the proposed solutions of the Task Force.

3 If the proposed solution has real possibilities, help students implement it in the school and community or send it to the Governor or County Solid Waste Management Office.
Considerations for implementation:

- Which groups need to know about the proposal?
- Which groups will initially oppose it and how can their concerns be satisfied?
- Which persuasive and educational techniques will be needed? (This question could lead to units on public speaking, advertising and marketing techniques, and effective educational and behavior modification methods.)
- Who will perform each task? Brainstorm tasks and draw up a plan of action with names, tasks, and dates.

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Handout # 1 ----
Segments of Society to Involve in Recycling

All segments of our society need to recycle if our solid waste problems are to be solved. Here is a list of people categorized by types of work. Add more occupations to the list, such as nurses, doctors, physical therapists, dentists.

1. Medical professionals as they work in hospitals.
   a.
   b.
   c.
   d.
2. Educators as they work in K-12 schools.
   a.
   b.
   c.
   d.
3. Communication experts as they work in TV stations.
   a.
   b.
   c.
   d.
4. Business people as they work in industry.
   a.
   b.
   c.
   d.
5. Entertainers as they work in their industry.
   a.
   b.
   c.
   d.
6. Government workers as they work in the armed forces or public service.
   a.
   b.
   c.
   d.
7. Working people as they work in factories.
   a.
   b.
   c.
   d.
8. Other professions and occupations you can think of.
   a.
   b.
   c.
   d.

Handout # 2 - Problem--Solving Process

Recycling Problem-Solving Process and Procedure for the State Recycling Task Force

1 Read the problem at hand. Write down ideas and solutions as they occur to you and underline important parts of the problem.

The Problem: In 1994 each person in the United States threw away 1,241 pounds of garbage, and as a nation the total gross discards in the municipal solid waste stream were 206.9 million tons.[4] In Washington State, 3.88 million tons of garbage were placed in landfills in 1994.[5]

The problems of waste are of space, environmental degradation, and cost. If we are having trouble finding space for waste now, where will the waste go in the future? Our enormous amounts of garbage produce volumes of leachate (the combination of rainwater and garbage that seeps through landfills that can contaminate ground water).

The decomposing garbage in landfills also produces methane. Methane is a colorless, odorless gas that is explosive when mixed at concentrations of 5 to 13 percent with air.[6] Methane forced the evacuation of homes and businesses near Seattle's Midway landfill and necessitated a multimillion dollar cleanup.

Getting rid of garbage is now very expensive. How much will you be paying when you start to pay taxes? Will leachate threaten water quality where you want to live?

Recycling is a part of the solution to this problem. Conscientious, community wide recycling is expected to reduce the waste stream by 25 percent. With composting, that percentage might be increased to 35-40 percent. Currently, Washington State residents recycle about 38 percent of the garbage they produce.[7]

Substitute House Bill No. 1671, passed into law in April 1989, called for a recycling rate of 50 percent by 1995 (Sec. 1, No. 9). You have been appointed by the Governor to serve on a Washington State Recycling Task Force. Your task is to design a plan to increase recycling to 50 percent by 2000 to meet the state requirements.

2 Time to brainstorm. Remember your brainstorming rules (Handout # 3). When brainstorming think of all segments of society to involve in answering the question: What incentives can we, as members of the State Recycling Task Force, create to motivate people to recycle at home, at work, and at play? Use the information you generated in completing Handout # 1.

3 Now time to analyze your ideas. Are any of the ideas you generated natural combinations? Are any of them duplications or not likely to motivate recycling? Combine or cross these out. Then select ideas with the most potential and narrow these down to the best five.

4 Elaborate on your five best ideas. For each state who, what, where, when (a general time line), and how the idea could be carried out. State why you think this idea would motivate people to recycle.

4 EPA., Characterization of Municipal Solid Waste in the United States 1994 Update, p. 29.
5 Washington State Department of Ecology, Solid Waste in Washington State, Feb. 1996, p. viii
6 Douglas M. Considine and Glenn D. Considine, Van Nostrand Reinhold Encyclopedia of Chemistry, 4th ed., New York, N.Y.: Van Nostrand Reinhold Company, Inc., 1984, p. 570.
7 Washington State Department of Ecology, Solid Waste in Washington State, Feb. 1996, p. viii

5 Evaluation of your ideas is very important. Here's a way to rank your ideas to identify the best solution.

Select five criteria to judge the merits of each idea. Some possible criteria are:

- least expensive to implement
- most readily accepted by the public
- will produce the greatest increase in recycling
- would collect the greatest number of items with long-term market value
- would involve most segments of society
- would result in greatest reduction in waste
- may be implemented quickly

Now list your five ideas and rank them on a scale of one to five, with one being the lowest rating and five the highest.

Handout # 3 - Creating Ideas

Brainstorming Guidelines for the State Recycling Task Force:

1. Don't Criticize Others
   They will lose their train of thought and stop generating ideas.

2. More Is Better.
   Write down as many ideas as you can. At this stage, don't worry about spelling, repetition, etc.

3. Connect Ideas When Possible
   If something someone says sparks a thought, say your idea. Connect parts of your ideas with theirs when possible.

4. Be Freewheeling and Don't Be Afraid of Crazy Ideas
   A crazy idea now may seem plausible and original after more thought and research.

Making Recycled Paper

Subjects: Science, Social Studies, Art

Grades: 2-5

Teaching Time: Two 40-Minute Class Periods

Focus: Learning a Process, Recycling

Rationale

Recycling conserves natural resources and reduces solid waste.

Learning Objective

Students will:

- Recycle used paper into new, usable paper.

Teacher Background

Paper cannot be recycled indefinitely, because the fibers break down eventually. However, many grades of paper can be de-inked, cleaned, and bleached, processes that allow paper to be reused as gameboards, tissue papers, ticket stubs, packaging, covers for hardcover books, insulation, and animal bedding.

Between 1978 and 1980, every American used 580 pounds of paper per year. In comparison, the people of Australia used 295 pounds per person per year and the people of Nigeria, 7 pounds.[1]

Paper constitutes 37 percent of the nation's municipal waste by weight in 1993.[2]

In the State of Washington in 1992, 29.5 percent of the combined residential and commercial waste stream was paper.[3]

In 1986, Washington State recycled 27 percent of total paper produced.[4] In 1994, Washington State recycled 74 percent of corrugated paper, 74 percent of newspaper, and 62 percent of high grade paper. [5]

Materials

- Blender or eggbeater and wide-mouthed container
- Pans
- Large mixing spoons
- Screens
- Cups to scoop pulp onto screens
- Blotters
- Dishwashing detergent
- Sponges or towels for soaking up water
- Scrap paper or newspaper to recycle
- Warm water
- A place to dry the paper
- Iron (to help dry the paper)
- Scale
- Optional: spices, dried flowers, herbs, vanilla, etc.

Pre & Post Test Questions

1. What natural resources are conserved when paper is recycled?

2. What kinds of paper can be recycled?

3. How should you separate paper to take to a recycling center?

4. What are the basic steps in making recycled paper?

1 William U. Chandler. "Materials Recycling: The Virtue of Necessity," Worldwatch Paper 56, Washington, D.C.: Worldwatch Institute, 1983, p. 13.
2 EPA, Characterization of Municipal Solid Waste in the United States, 1994: Update, p. 29.
3 Washington State Department of Ecology, 1992 Washington State Waste Characterization Study,. Vol. 1, July 1993, p. II-27.
4 Ibid., p. 22.
5 Ibid. Solid Waste in Washington, Feb. 1996, p. viii.

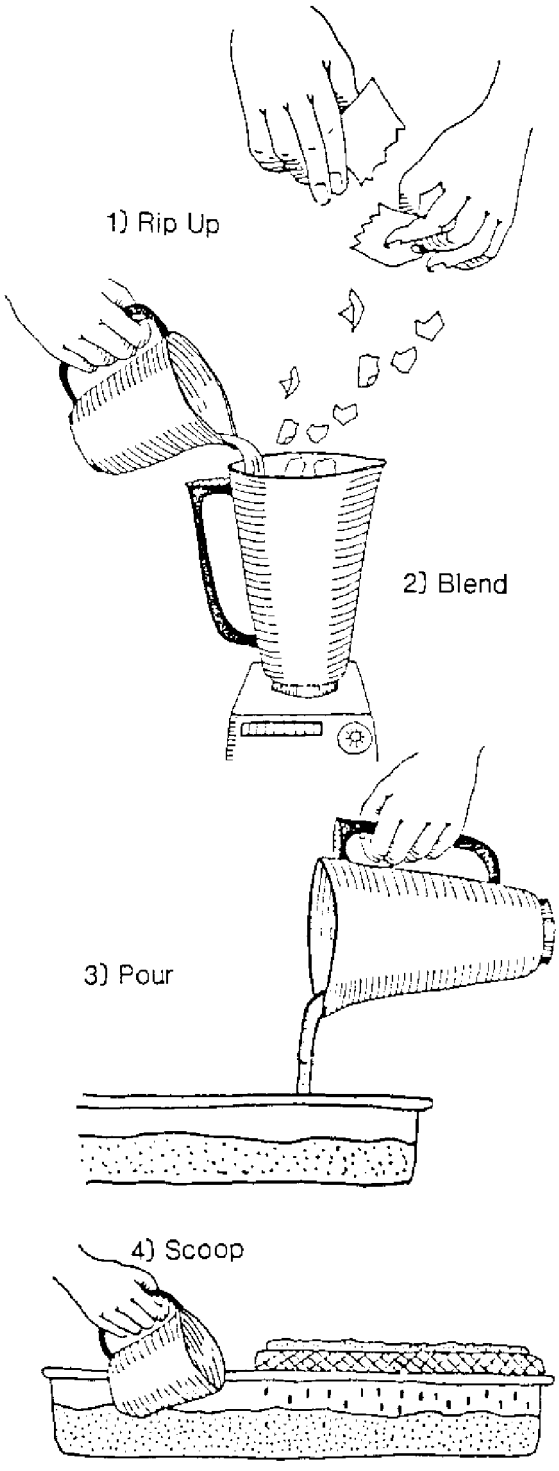
Learning Procedure

(See also diagrams on p. 141)

1 Make recycled paper by using the following procedure:

- Tear sheets of used paper into small strips, about one-inch square. Loosely pack into blender until 1/3 to 1/2 full. Add warm water until blender is 2/3 full.
- Blend (with lid on) until the paper looks like oatmeal mush (5-10 seconds). If you are coloring the paper by using scraps of construction paper, add them now. (If you desire white paper, add a small amount of dishwashing detergent to de-ink the paper.)
- Pour into the pan. When pulp is mush consistency, add about 1/2 inch of water for every blender full of pulp, adding more or less depending on thickness of paper desired.
- Scoop the pulp mixture evenly onto the screen with a cup (hold the frame over 1/2 of the pan). If students want to add things individually to their pulp (colors, paper bits, glitter, spices), they add it to their cupful. Let the pulp drain.
- Place a piece of blotter over the wet sheet of paper on the screen, then flip the screen over so the paper is between the blotter and the screen, with the screen on top.
- Soak up extra water with a sponge. This water can be squeezed out of the sponge back into the pulp mixture.
- Lift off the screen and place the new paper in a safe place to dry. Drying takes one or two days. Exchange blotter and dry paper towels every few hours if you want the paper to dry more quickly. The paper should not be touched or unnecessarily disturbed while drying. You may iron the paper to speed up the drying process. (Place a sheet of paper between the new paper and the iron.)

Special options: You may use deckles such as cookie cutters to create unusual shapes for your paper, or you may add glitter or food coloring to the mixture.



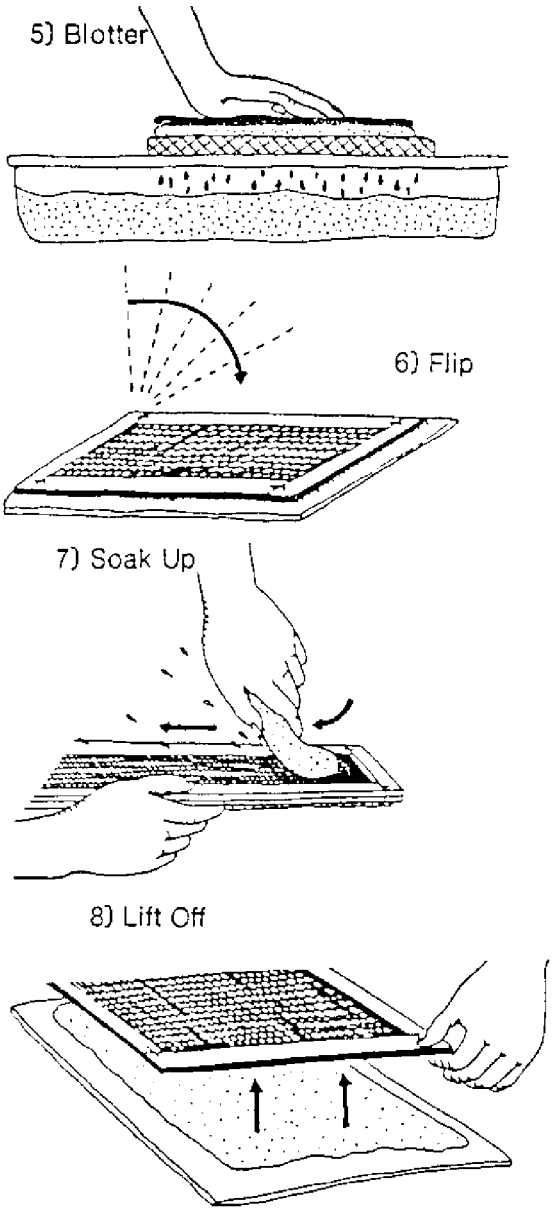
2 As a recycling experiment, you can weight the paper before placing it in the blender, and then weigh the recycled paper after it dries. What conclusions can you make about yield from the original paper? What are the benefits of recycling paper? What are the drawbacks? Can paper be recycled indefinitely? (No, eventually the fibers break down.)

Extended Learning

1 Contact your local recycling center or the Department of Ecology's Recycling Hotline, 1-800-RECYCLE, to learn what types of paper are commercially recycled, the location of the paper recycling centers, and the proper ways to bundle and separate different types of paper.

2 Visit a pulp mill. Find out if the mill uses only virgin timber, a mixture of virgin timber and recycled paper, or only recycled paper.

3 Weigh all the waste paper the class generates in a week. The next week, separate all the paper suitable for recycling. Then weigh again the amount that gets thrown away and determine how much paper the class can save for recycling. Have a contest with another class to see who can recycle the most paper.



Acknowledgment

For paper making ideas, Bellingham Community Recycling "Paper Making Kit."

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Ibid. Solid Waste in Washington State, Fourth Annual Status Report, including the 1994 Recycling Survey, Feb. 1996, Publ. # 96-500.

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Paper From The Urban Forest

Subjects: Science, Social Studies
Grades: 2-5
Teaching Time: 20 Minutes
Focus: Recycling Paper Saves Trees and Energy

Rationale

Fiber from the "urban forest" ---- recyclable paper ---- can be a raw material for making paper just as is fiber directly from trees of the natural forest. As paper from trees becomes more difficult and environmentally costly to obtain, paper from the "urban forest" will become more valuable.

Learning Objective

Students will:

- Understand that paper can be made both from trees and from recycled paper.
- Understand some of the energy and environmental costs of paper production.

Teacher Background

See chart on the following page.[1]

Pre & Post Test Questions

1. What is the "urban forest"?

2. What are some of the raw materials for paper making found in the "urban forest"?

3. What effect does the cutting of forests have on soil, streams, fish, and air?

4. Can you name five different uses of paper?

Learning Procedure

1 Discuss about how long it takes a tree to grow to a size big enough to be harvested. (In Washington State, it used to take 50 to 60 years, but younger and smaller trees are now being processed.)

2 Discuss ways in which energy is used in the making of paper. (Energy to run logging equipment, factory machinery, etc.)

3 Discuss how cutting trees for paper affects the environment. What are the effects on wildlife, fish, soil, and air?

4 Discuss where else we can look for a supply of raw materials with which to make paper, as forests near cities and paper mills get cut down.

5 Put the 1992 paper recycling statistics on the board. (See the chart on the next page.) Which of the four categories needs the most improvement? Point out that 31 percent of the total paper waste stream in Washington State (368,439 tons) was scrap paper. How can this problem be improved? (regulations, recycling, restriction of "slick" paper products).

Extended Learning

Set up five boxes in your home or school for the five categories of paper. For one week, separate all waste paper into the five boxes. Weigh each pile of paper. Rank your categories by weight. Discuss how your home or school paper waste stream compares with the survey.

1 Washington State Department of Ecology

1992, Washington State Paper Recycling

Category	Percent Recycled
Corrugated	62%
High grade paper	58%
Newspaper	58%
Mixed Waste Paper	32%

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As The Worm Churns

Subjects: Science, Woodshop, Home Economics

Grades: K-12

Teaching Time: 30 to 45 Minutes, With Periodic Review

Focus: Household Waste, Waste Reduction, Composting

Rationale

When we throw food scraps into the garbage, we turn a resource into a liability. At significant financial and environmental cost, waste has to be picked up, transported, and buried or burned. Composting our kitchen waste by using worms provides an alternate use for kitchen waste and creates soils.

Learning Objective

Students will:

- Discover a beneficial, low technology way to reduce household waste.
- Understand the natural process of biodegradation and soil production.
- Know how to improve soil through worm composting.
- Learn what a landfill does.
- Learn the benefits of composting.

Teacher Background

Review the lesson "Take A Look In Your Garbage Can!" p. 129.

Redworms, *Eisenia foetida,* are used to process kitchen waste into high quality garden compost. Properly constructed and maintained, the bins do not give off an offensive odor.

Interesting Fact:

In Washington State in 1992, food waste constituted about 12 percent of residential solid waste.[1]

Worm bins provide the following benefits:

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

The formula for sizing a worm bin is simple: 1 cu. ft. is needed for each pound of food waste generated each week. If your class has access to about four pounds of food waste each week, you need to build or buy a 4-sq.-ft. worm bin. (Half-size bins are also effective; they require half the amount of food and materials.)

Woodshop classes could make a worm bin as a first project. For a 4-cu.-ft. bin, four 2' x 12" sheets for the sides and two 2' x 12" sheets of plywood for the top and bottom need to be cut. After the sides and bottom are nailed together, the top can be hinged. About nine to twelve holes should be drilled into the bottom and sides of the box. The holes provide air for the worms. A cookie sheet or plastic layer should be placed under the box to catch any debris or water falling through the holes. If your school has no shop class, you can use wood, metal, or other containers, as long as they are not filled deeper than 12 inches. A piece of heavy duty plastic may be used as a cover. For a 4-cu.-ft. worm bin you will need:

- 1 box no deeper than 12 inches (to prevent anaerobic conditions from developing)
- 1 room or space with a temperature between 55°F and 77°F

1 Washington State Department of Ecology, 1992 Washington State Waste Characterization Study, Vol. 1. July 1993.

- 6 pounds of paper for bedding
- 1-2 handfuls of soil (optional)
- Several eggshells
- 1 pound of *Eisenia foetida* (redworms)
- 4 pounds of food waste per week

Shred the paper by tearing it into strips about 2 inches wide. Put the paper in a bucket, and slowly pour water in while fluffing the paper occasionally. Let the paper segments drip until dripping subsides. Put wet strips of paper in the worm box, and sprinkle in several eggshells (for worm reproduction). Gently place the worms in the box, leaving the top open until the worms burrow down. Close the lid or cover with a black plastic sheet. (Since worms do not react to red light, a red plexiglas side panel or lid would allow direct observation of worm activity.) Bury food in the box each week, rotating the burial location.

The general formula for worm bins: for each cubic foot of bin, you need 1.5 pounds of bedding, 4.5 pounds of water, 1 pound of garbage per week, 4.5 ounces of redworms, a bit of soil and calcium carbonate.

To change worm bedding, either dump the contents of the bin under a bright light and brush the layers of compost away (the worms will move away from the light and gather at the bottom of the pile); or pull the compost plus worms to one side of the bin and add new bedding to the vacant side. An alternative is to use only one-half of the box at a time; put your bedding and worms in one side of the worm bin. Continue to bury food into the bedding until it is composted. Then add new bedding to the empty half of the bin. Begin burying food on the new side. Allow one month for the worms to migrate to the new side. Remove the worm castings. Repeat the process. To be certain you have all the worms from the first side, expose the worms to bright light, then wait 20 to 30 minutes. Remove the top layer until worms are exposed. Repeat until the worms are in a mass in the center of the old bedding, then add the mass of worms to new bedding. Use the soil formed by the castings on potted plants or in the garden.

Some of the foods that will work well in the worm bin are apples, apple peelings, baked beans, banana peels, biscuits, cabbage, cake, cantaloupe (a worm favorite), celery, cereal, cheese, coffee filters, coffee grounds, cornbread, cottage cheese, cream cheese, Cream of Wheat cereal, cucumbers, eggshells (good source of calcium carbonate), farina, grapefruit peels, grits, lemon, lettuce, Malto-Meal cereal, molasses, oatmeal, onion peel, pancakes, pears, pineapple, pineapple rind, pizza crust, potatoes, Ralston, tea bags, tea leaves, tomatoes, turnip leaves, and watermelon (another favorite). Avoid putting plastic, bottle caps, rubber bands, sponges, aluminum foil, or glass in the box, and don't allow the box to be used as a cat's litter box. Fruit flies can be avoided by burying the food waste completely.

The worm bins need little routine maintenance. Depending upon the desired outcome, the bedding should be changed every three to six months. After three months, one will find the number of redworms is high; after four months, the number of redworms will still be high, and the quality of compost will be fairly good; after six months, many redworms will have died, but the quality of the compost will be very good. The resulting compost will be primarily worm castings (worm manure).

Materials

- Wooden box (2' X 2' X 12")
- Paper
- Water
- Dirt
- Redworms *(Eisenia foetida*)
- Calcium carbonate
- Food waste

Pre & Post Test Questions

1. What are worm castings?

2. How many ounces or pounds of worms, bedding, water, and food waste do you need for each cubic foot of a worm bin?

Learning Procedure

1 Ask the school's shop class to build a 2'X 2' X 12" wooden bin (see specifications above).

2 Talk about the impact of food wastes on the solid waste stream. Discuss alternative methods of handling food wastes. Introduce the idea of using redworms (*Eisenia foetida)*.

3 You will need one pound of redworms for the bin. Ask the students to look for and collect redworms (not nightcrawlers). Hints for where to look: barn-yards under mulch, in compost piles, under decomposing lumber. You may need to supplement the redworm find by obtaining some from a commercial grower. Consult the resources book for suppliers.

4 Set up your worm bin. For a 4-cu.-ft. bin, bury four pounds of food waste in the bin each week, making sure to rotate the location of the burial (mentally dividing the bin into nine squares would probably be helpful).

Extended Learning

1 (Grades K-12) Study the reactions of worms to different colors of light. Study the food preferences of young versus mature worms. Using four worm bins, study the reactions of the worms to the four food groups.

2 (Grades 4-12) Keep records of the temperature of the compost, room temperature, amount and types of food fed to the worms, and total volume/weight of the compost. Relate these variables to each other and to any variables you identify.

3 (Grades 6-12) Study the worm's life cycle. How do worms reproduce? Do you see any babies? How long do the worms seem to live? Do you see any dead worms?

4 Study the other organisms present in the worm bin. What is the interrelationship of these organisms?

5 Study the effects of various mixtures of vermi-compost, peat moss, soil, and perlite on potted plants.

6 Calculate how much food the households of class members throw away in a day. Base the calculation on the fact that each Washington State resident produces about 7.7 pounds of garbage in the home per day.[2] Of this residential total, about 12 percent of the garbage is food.[3]

7 Discuss: Why, in a hungry world, do we throw away so much food? In the United States in 1993, we threw away 13.8 million tons of food, or 6.7 percent of our total solid waste stream.[4]

2 Ibid. Solid Waste in Washington State, Feb. 1996, p. 54.
3 Ibid. 1992 Washington State Waste Characterization Study, Vol. 1, July 1993.
4 EPA., Characterization of Municipal Solid Waste in the United States, 1994 Update, p. 29.

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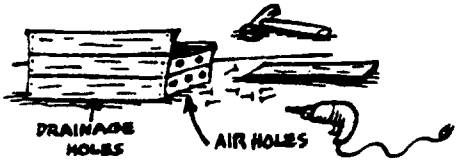
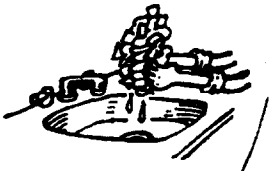
As the Worm Churns

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

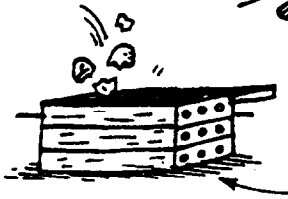


2. Shred paper for bedding.

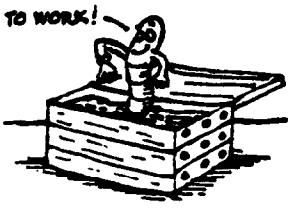
3. Wet the bedding
   and squeeze out excess water in the sink.



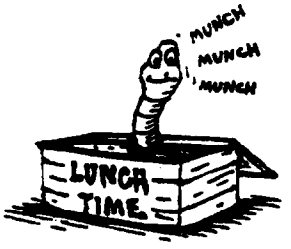
4. Sprinkle in 1 or 2 eggshells.



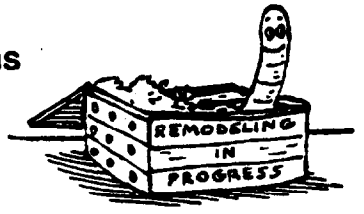
5. Place worms in the box.



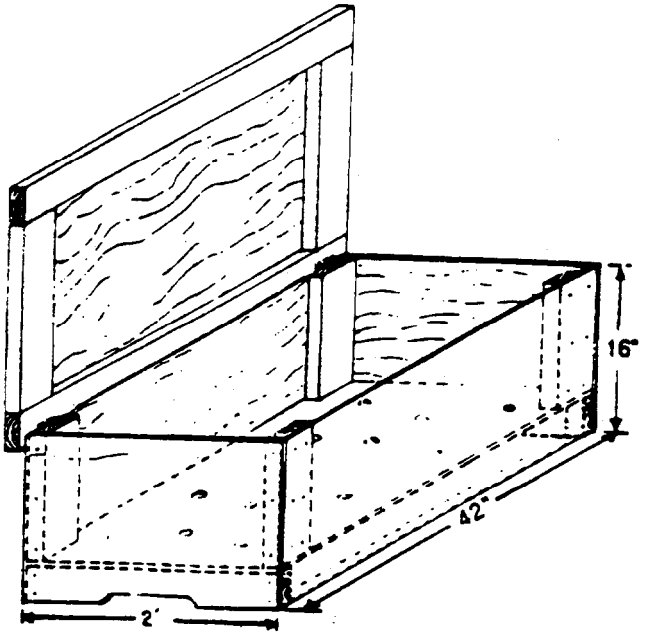
6. Bury garbage for food once a week.
   (Be sure you rotate the placement of the garbage).



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



I-2-3 Worm Composting Bin



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

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

This bin can be built for about $25 with new wood and hardware, or less using recycled materials, Worm bins can also be made from wooden boxes or other containers. Any worm bin must have drainage in the bottom and a tight fitting lid to keep moisture ***in*** and pests out. A starter batch of worms can be purchased at a small additional cost, or find some in an old compost pile! For more information see Mary Appelhof's book, Worms Eat My Garbage.

Materials

1 l/2” treated sheet of plywood

1 12 foot 2X4

1 16 foot 2X4

2 lbs. 6d galvanized nails

l/2 lb. 16d galvanized nails

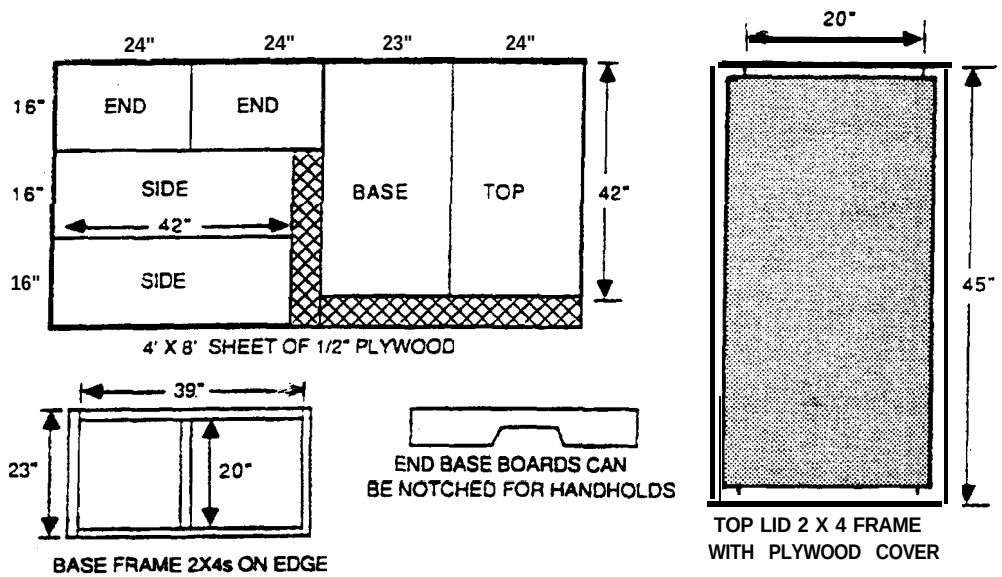
2 galvanized door hinges

Tools

Tape measure, skill saw or rip hand saw, hammer, saw horses, long straight edge or chalk snap line, screwdriver, and drill with l/2” bit.

Use eye and ear protection.

Construction Details



Measure and cut plywood as indicated in drawing above. Cut the 12 foot 2X4 into five pieces: two 39", two 23”, and one 20” long. Nail the 2x4s together on edge with two 16d nails at each joint as illustrated in the Base Frame diagram. Nail the plywood base piece onto the 2X4 frame.

Cut four 1 foot lengths out of the 16 foot 2X4. Take each plywood side piece and place a one foot 2X4 under each of it’s ends so that the 2X4 is flush with the top and side edges of the plywood, and nail the boards into place. Nail the side pieces onto the base frame. To complete the box, nail the ends onto the base and sides. To reinforce the box and be sure there is a nail staggered at least every 3 inches wherever plywood and 2x4s meet. Drill twelve l/2” holes through the bottom of the box for drainage.

To build the lid, take the remaining 12 foot 2X4 and cut it into two 45” pieces and two 20” pieces and lay them flat, short pieces on the inside as indicated in diagram above, so that the plywood top is inset from the edges of the 2X4 by 1 -l/2” all the way around the perimeter. Nail the plywood onto the 2x4s and on the underside of the 2X4 lid frame, so that the lid will stand upright when opened.

How To Recycle In School

Recycling is part of our daily lives. Recycling programs are being established in communities throughout the state. Schools have an excellent opportunity to reduce and recycle their waste. A school waste reduction and recycling program saves energy, conserves natural resources, preserves landfill space, reduces pollution, and provides a positive, hands-on educational experience for students, teachers, and other school personnel. A school waste reduction and recycling project may provide an important public service by presenting the school in a leadership role in the community.

The ‘‘Waste Not in Washington’’ Bill (ESHB 1671), passed into law in 1989, states in Section 54, ‘‘Each public school shall implement a waste reduction and recycling program conforming to guidelines developed by the office.’’ Program guidelines are available in limited quantities from Department of Ecology. Ask for the book, ‘‘How to Make Waste Reduction and Recycling Happen in Your School.’’

The Department of Ecology has developed an awards program for waste reduction and recycling in public schools. Annual monetary awards will be given to schools achieving the greatest levels of waste reduction and recycling. For further information call 360-407-6140.

Goals

Establish attainable goals to ensure continuing success in recycling and waste reduction. Goals may include:

1. Conserve resources and save energy
2. Reduce school waste produced and reduce cost of disposal
3. Educate students and staff in waste management concepts and practices
4. Establish and maintain a successful waste reduction and recycling program in school
5. Participate actively in solutions to environmental land, air, and water pollution problems

Needs Assessment

Waste Reduction

In order to develop a comprehensive waste reduction program, conduct an inventory of current purchases to assess waste reduction possibilities (i.e., what recyclable materials do you purchase? What recycled materials are purchased by your school district?).

Recyclable Materials

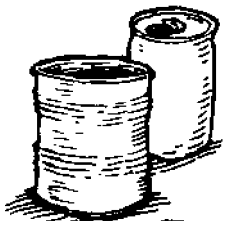
Before initiating a recycling program, conduct a waste audit to determine what waste is being generated, what is being throw away, what currently is being recycled, and what could be recycled. Conduct a study of existing disposal practices, including a breakdown of the current waste stream content by kinds of materials and volume per container in yards. Also calculate current disposal costs per container and total disposal cost on a monthly basis.

The inventory list below includes example recyclable materials found in schools.

Types of Paper

- White ledger paper
- Computer paper
- Workbooks
- Magazines
- Newsprint
- Construction paper
- Cardboard

Metals

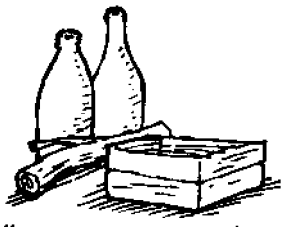


- Aluminum
- Tinned cans
- Steel
- Iron
- Copper

Plastics

- PETE (pop bottles)
- HDPE (Milk jugs)
- LDPE (clear bags)
- Other

Others



- Glass
- Wood products
- Compostables

Market Research

Before initiating a recycling program, a market search should be conducted. Recyclers may collect only certain recyclable materials.

To identify recyclers in your area, contact the Washington State Recycling Hotline 1-800-RECYCLE.

Questions Schools Should Ask The Recycler

What materials will you accept?

Will pay for? (How much?)

Will collect at no cost?

Will collect but for a fee? (What is the fee?)

How should materials be separated and collected and stored?

What will the recycler provide?

Containers?

Promotional materials?

Transportation of recyclables from school?

Frequency of service?

Monitor and report totals of materials being recycled?

How frequently will materials be picked up?

What is the minimum or maximum quantity accepted for collection?

Will the recycler provide a written contract for collection of materials for a specified length of time?

Operations Planning

Waste reduction tips

- Reuse paper
- Purchase recycled paper
- Purchase recyclable/reusable materials

Hints for first-time recycling programs

Form a committee with representatives from all school groups to develop a strategy for education, promotion, collection, storage, transportation, monitoring, evaluating, recording and reporting the results of the waste reduction and recycling program.

Initiate a recycling and waste reduction educational program in your school for students, faculty, clerical staff, administrators, and custodians.

Designate a coordinator to oversee the program.

Initial pilot project

Pick one item (i.e., white paper, aluminum)

Locate a recycler who will accept your source separated materials with the understanding that you may add more recyclable items later. Be certain you have a valid contract with your vendor that meets your needs. See "Questions Schools Should Ask The Recycler."

Monitor the progress of your project noting successful components and the aspects that need modification.

Measure, record, and report the amount of material being recycled.

After a designated period of successful recycling, add a new recyclable item to the program.

Renew interest in the recycling program with awards, media events, or contests among different groups in school. (The local PTA may be a good resource for promotional campaigns.)

Problems that may arise

- Equipment and storage needs
- Contamination or vandalism of recyclables
- Codes that need to be addressed (i.e., fire, health, safety, etc.)
- Poor participation rates
- Fluctuating markets may affect prices for materials recycled or they may affect recycler participation in the program

Note: Before instituting a waste reduction and recycling program, schools need to contact the local fire marshal. For paper and other flammable materials, fire codes designate policies for storage of materials, preparation of materials, placement of collection receptacles, and types of collection receptacles permitted. Fire codes also address frequency of collection and the types of materials collected.

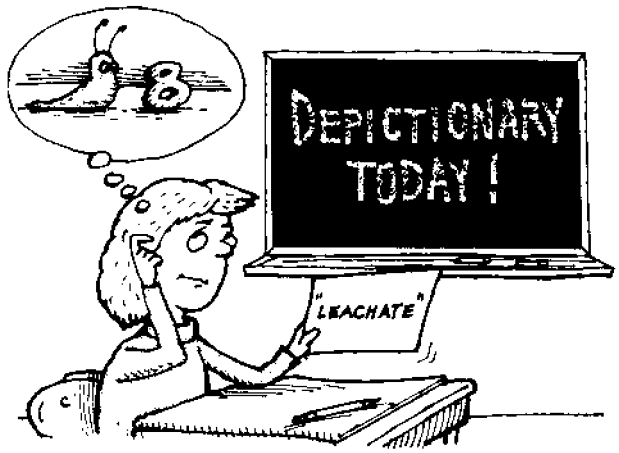
Recycling tips for advanced programs

- Source separate all school materials which are recyclable
- Initiate a composting program in classrooms or on school grounds
- Research possible new markets or vendors before adding materials
- Calculate costs: Include savings from reduced garbage collection fees

The in-school waste reduction and recycling program can be beneficial for students, teachers, and staff in the school and for the community at large.

Depictionary

Subjects: Science, English
Grades: 3-8
Teaching Time: 40 Minutes
Focus: Waste Management, Resource Conservation, Waste Reduction, Recycling Vocabulary



Rationale

Knowledge of the vocabulary of resource conservation is basic to understanding waste reduction and recycling.

Learning Objective

Students will:

- Learn the basic vocabulary of waste reduction and recycling.

Teacher Background

Read the Glossary.

Materials

- Deck of index cards with vocabulary words written on them

Pre & Post Test Question

Ask students for the definitions of any of the attached vocabulary words.

Learning Procedure

1 Divide the class into two teams.

2 One student from each team views the word shown by the teacher and draws illustrations of the word on the board.

3 Teams have 60 seconds to guess the word illustrated by drawing. The first team to guess the word gets a point. That team can earn an additional point by giving the correct definition of the word. If neither team is able to guess the word, reveal the answer. For definition of the word list see the Glossary. You may wish to write the definitions of the vocabulary on the back of the cards and have students read them.

4 New students on each team view and draw the next word and the game continues.

Suggested Vocabulary List

Aluminum - noun

Aquifer - noun

Biodegradable - adjective

Compost - verb

Garbage - noun

Glass - noun

Ground water - noun

Hazardous waste - noun

Landfill - noun

Leachate - noun

Litter - noun

Methane - noun

Paper - noun

Plastic - noun

Pollution - noun

Recycle - verb

Throw away - verb

Wildlife - noun

Difficult Vocabulary List

energy - noun

Environment - noun

Inorganic - adjective

Natural resources - noun

Nonrenewable resource - noun

Organic - adjective

Packaging - noun

Renewable resource - noun

Extended Learning

Add new environmental terms to your list from magazine articles, TV, or newspapers. Define the terms.

Bibliography

Resource Recycling Inc. Glossary of Recycling Terms and Acronyms. Portland, OR: Resource Recycling Inc., 1989.

The Throwaway Three

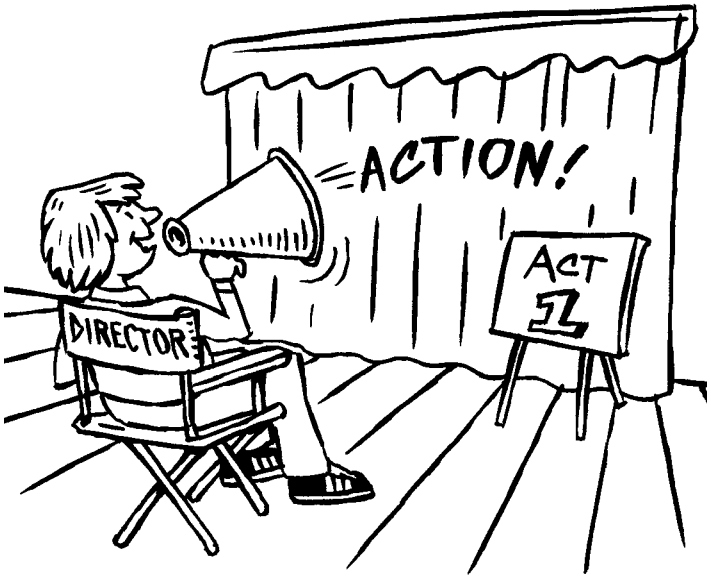
(a skit)

Subjects: Social Studies, Language Arts, Drama

Grades: 4-6

Teaching Time: Two 40-Minute Sessions

Focus: Litter Control, Recycling



Rationale

We can't throw away our trash. There simply is no such place as "away." Care is always required to prevent our trash from having bad effects on our lives.

We can't burn it all. Most of the burning requires expensive and often elaborate controls, to prevent air pollution. There is always ash or something left over which must be buried.

We can't bury it all. Not enough places are available. Besides, plastics and modern synthetics do not rot when buried.

We are literally running out of some natural resources, so that any form of disposal of certain goods is self-defeating.

Learning Objective

Students will:

- Become aware that historical methods of getting rid of solid waste (throw it, bury it, or burn it) won't solve modern urban garbage problems.

Materials

- Skit script
- Props

Pre & Post Test Questions

List three waste disposal problems today's society must solve which did not exist 100 years ago.

Explain how this skit helped you find ways to solve your waste problems.

Who were litter makers in this skit?

Learning Procedure

1 Prepare materials as described in the skit script on the following sheets. Encourage students to make props and costumes from recycled or reused materials.

2 Work with students to develop a production which could be performed for other classes, for parents, or for a group in the community.

Bibliography

Bradley, Fay. "Throwaway Three." Lessons from Litter. Atlanta: Atlanta Clean City Commission, 1979.

U.S. Environmental Protection Agency. Let's Recycle: Lesson Plans for Grades K-6 and 7-12. Washington, D.C.: Office of Waste and Waste Management, 1980.

THE THROWAWAY THREE

PROPS

Person 1

This is the tale of the Throwaway Three,
Of Man and his Garbage throughout his-to-ry:
Now they're very nice people, like you and like me,
Who all have a problem, as you will soon see-
What shall they do with their garbage and trash?

All

Why, throw it! Or bury it! Or burn it to ash!

Person 3 - 50,000 BC (Cave dweller)

I am a cave dweller who lives on the ground. — Skins
What do I do with old stuff all around?
Why, burn it, like meat; burn it up in the fire;
Or bury it like bones, in the muck and the mire.

All

Yes. throw it, or bury it, or burn it to ash!
That's how we always get rid of our trash!

Person 1 - 200 BC (Roman)

I am a Roman who lives in the town. — Roman Helmet
Our laws won't allow me to just throw it down. — Bag of Trash
I have to drag it away for a mile
And then I can dump it, forget it, and smile!

Person 2 - 1200 AD (Briton)

I am a Briton, wary and quick; — Stack of Trash
Down on our street it can get pretty thick.
When housewives up there want to pitch out their goo,
They just leave it out there and yell: "Gardy-loo!"
(Person 1 stands on chair and yells, "Gardy-loo!")
It will stay there and stay there until the next rain,
Or until our fair London should burn down again.

All

Oh, what do we do with our garbage and trash:
We throw it. or bury it, or burn it to ash!

Person 3 - 1630 (Settler)

I am the settler. I came without much, — Pilgrim Hat
But everything else I must make with my hands.
So I don't throw out much - I use all I can.
Cloth scraps become quilts: I reuse my bent nails

It will **be** long time 'fore the next trade ship sails.

Person 1 - 1700 (Colonist)

I am a colonist; now Life's not so tough. — Coonskin Hat
We have trade between cities that brings lots of stuff — Leather
And some things are made by our townfolk today,
I could buy a new harness, throw this old one away.
We have pigs and hogs running loose in our street,
If I toss it out there, they'll eat it up neat!

Or I might bury it right over there.
Or I might burn it; nobody would care.
You see: the New world is the same as the Old!
We trashmakers come from the time-honored mold.

All

What are we still doing with garbage and trash?
You guessed it! Throw it away, or bury it, or burn it to ash!

Person 2 - 1890 (Industrialist)

I'm the industrial person and new on the scene, — Engineer's Cap
I mass-produce goods with my trusty machine. — 3 Sweaters
This sweater, handmade, took a week in days of yore, — (One handmade;
But now in one hour, I can make forty-four. — two machine-made)
I make things so cheaply, you can now afford two
And throw out twice as much trash as you need to do.

Person 3 - 1950 (Scientist)

I am the scientific person in the new post-war age. — Lab Coat
We've learned a few tricks while the war shortage raged.
When we couldn't get natural stuff to process
We invented synthetics to replace the rest.

Person 2 (Industrialist)

Rayons and nylons, acrylics and plastics, — Nylon stockings
For furniture and clothing and even elastics: — Plastic Bags &
Forget your old woolens and silks and your cotton; — Containers
Real wooden toys and washboards are forgotten.

Person 1 (Scientist)

Our new stuff will last 'til forever, you see — Perma-pressed
Even when it's worn out to you and to me. — shirt
Permanent pressed, pre-sized and pre-shrunk
When dingy and old, it's still permanent "junk"
(Person 1 yells, "Junk")

Person 2 (Industrialist)

We make instant menus that come in a PACK. — Plastic Bag
You just boil the food in its own plastic sack. — TV Dinner
Or our TV dinner in its tinfoil tray
It's quick; you don't wash it; just throw it away!

Person 3 (Scientist)

We make lots of TVs and clothes dryers, too.
Don't ask for a trade-in; you're kidding, aren't you?

Broken Small Appliance

Person 2 (Industrialist)

Our new cars all change with each model year,
Don't try to repair them, the cost's much too dear.
Besides, we don't bother to make last year's parts
for Skylarks, or Novas, or Cougars, or Darts.

Toy Car

Person 3 (Scientist)

It's the New Thing, the NEW that America craves.
So out, out with the old stuff, away to its graves.

Person 2 (Industrialist)

So what if there're more of us buying more goods?
So what if they won't rot away as they should?

Person 1 (Indian)

Now wait just a minute! You cannot fail
To include me in your historic trash tale.
We Indians lived simply, on prairies, in woods,
We made no high trash piles, nor mass-produced goods.
Let me be your critic, show you where you stand;
And tell you just how you're defiling our land.
Your new-fangled goods will not rot away.
When you throw them all down they remain where they lay
Then you say you will bury them deep in the ground:
All your urban trash will make quite a mound!
So then you would burn it, in smoldering masses
And fill up our air with smoke, deadly gases!
Oh, all of your answers have faults everywhere:
You'll either ruin the water, the land, or the air.
What's more, your resources-your lumber, your ore-
Get smaller each year than the year before.
And what's more-this old earth's not making any more.

Indian Headband

Person 2 (Industrialist)

You're right. Our resources are shrinking away
While our garbage problem grows bigger each day.
We're always converting resources to refuse
Instead of recycling them for reuse!

Throw Out Old Blanket and Cola Bottle

Person 3 (Scientist)

Oh stop it! Don't drop it! We'll think of a way
To make food for cows that's much better than hay.
Don't burn it, return it--we'll make something new,
A vase or your mother, a spyglass for you.

Pick Up Orange Peels
Clear Bottle Flower

(Flower in bottle for vase, flower out, bottle held up to eye for spyglass)
Don't bury it, carry it-back to the mill.
We'll make a new blanket to ward off the chill.
(pick up old blanket and wrap around shoulders)

Person 2 (Industrialist)

It's time we progress past the Disposal Age
And make recycling the popular rage!
We'll have to give up old solutions for trash
And all realize that its pure balderdash -to just

All

Throw it, or bury it, or burn it to ash!

DISCUSSION

The skit shows that people have historically gotten rid of solid waste successfully by throwing it out, burying it, or burning it. But none of these methods solves modern urban garbage problems. The discussion should attempt to reinforce this concept. One way this can be done is to discuss the characters in the skit: how they disposed of their garbage or trash and why their method of doing so was either satisfactory or not satisfactory.

Cave dweller:	Threw it, burned if, buried it. These acts still did not cause a problem, for the same reasons.
Roman:	Threw it. Tossing out garbage began to be a problem because of the many people who lived in cities, but if was easily solved by taking the garbage out of the city.
Briton:	Threw it. A problem grew because more and more people moved to the cities, thus producing more trash than they could get rid of in the city.
Settler:	Had virtually no garbage.
Colonist:	Threw it, burned it. buried it. With greater trade came more things to be discarded.
Industrialist:	With a greater concentration of people in cities than ever before, and more buying because machine-made goods were cheaper, much more was thrown out.
Scientist:	The big change to synthetics and the use of enormous amounts of natural resources are causing tremendous problems.

Solid Waste Survey

Subjects: Language Arts, Social Studies, Math
Grades: 4-8
Teaching Time: 30 Minutes, Plus Follow-Up
Focus: Solid Waste Disposal

Rationale

Most people are not aware of the size of the solid waste problem in their community, or the expense required to deal with it.

Learning Objective

Students will:

- Become aware of specific facts to help them understand what happens with solid waste in their community.

Pre & Post Test Questions

1. How is solid waste disposed of in your county?

2. On the average, how much solid waste per day is produced by each citizen of Washington State?

3. In your county, how much does it cost per ton to dispose of solid waste?

Learning Procedure

Step A.

1 Organize the class into six research groups. Have each group find information on one or more of the following questions. Select a representative from each group to work on a committee to compile all information and produce a fact sheet, newsletter, poster, or other publication.

- What is the population of your community? How many families? Check growth over the past ten years by county. (Obtain information from your city hall or the United States Bureau of the Census.)
- How many tons of garbage does your community dispose of each day? (This information may be obtained from the city or county Department of Public Works or the Department of Sanitation).
- How many pounds of garbage are disposed of per person per day? Per year? The average in Washington State is 5.2 pounds per person per day.[1] The average for each person in the U.S. for municipal solid waste is 3.4 lbs.[2]
- How much does it cost to dispose of solid waste per ton?
- How is garbage disposed of in your community? Is it burned or buried? Is any of it subject to resource recovery processes or organized recycling; for example, separate collection of newspapers, cans, and bottles?
- Are there other recycling programs in your town? Are they run by the city or by private citizens?

2 Invite a city or county solid waste manager and a recycler to speak to the class.

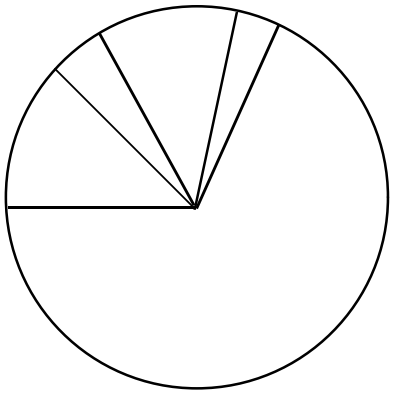
3 **Step B.**

- Have each research group decide upon the best way to present its information. For example:
- Prepare a graph comparing county population growth over the past ten years with growth of the volume of solid waste.
- Prepare a poster depicting the individual's

1 Washington State Department of Ecology, Solid Waste in Washington State, Feb. 1996, p. viii.
2 EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update, p. 3.

daily contribution to the community's solid waste. Divide the population of the community into the tonnage of waste per day. Calculate the annual contribution of each individual.

- Prepare a layout like the one below and compare the costs of these items in your school and community with the costs of solid waste disposal for a year.
- Prepare a pie chart showing the relative costs of the various school and community programs and services, including solid waste disposal.
- Discuss how recycling could reduce your community's solid waste and the expense of its disposal.



Program	Cost Per Year	Cost Per Individual Per Year
Solid Waste Disposal School		
School Basketball Program		
School Band Program		
School Safety Patrol		
Solid Waste Disposal County		

Resources -

Video Tape: Trash Monster. California Solid Waste Management Board. 1980. 12 min.

Bibliography

EPA, Characterization of Municipal Solid Waste in the United States, 1994 Update, Publ. # EPA 530-S-94-042.

Washington State Department of Ecology, Solid Waste in Washington State, Fourth Annual Status Report, Including the 1994 Recycling Survey, Feb. 1996, Publ. # 96-500.

Solid Waste: What's My Responsibility?

Subjects: Government, Contemporary Problems, Psychology, Ethics

Grades: 9-12

Teaching Time: One to Two Class Periods

Focus: Solid Waste, Problem Solving, Personal Responsibility

Rationale

People often feel powerless to do anything about enormous economic, political, or social problems. Solid waste is an example of an issue where personal action toward a solution may seem insignificant. Even if individual action by itself cannot solve these large problems, it can be the basis for a positive, personally enriching way of living.

Learning Objective

Students will:

- Examine how their perception of a problem affects their response to that problem by using solid waste as an example.
- Examine the individual's and government's responsibility in solving social problems, and define ways they, acting as individuals or in a group, can take responsibility for solutions.

Teacher Background

See the Solid Waste Fact Sheets, on pp. 5-16, and the Solid Waste Introduction, p. 1.

Pre & Post Test Question

What are two things individuals can do to help solve problems of solid waste?

Learning Procedure

Part I: Personal Responsibility And Solid Waste

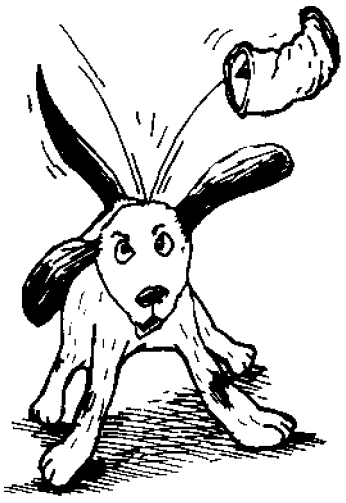
1 Have students read the following article, "My Twenty Foot Swath," p. 172.

2 Ask students questions about the man in the article:

- What worries this man?
- What does he try to do about it?
- Does he think his response is effective?
- What response do you make when faced with a problem of this kind?
- What is RAO? (Responsibility Assumption Overload) Have you ever felt RAO? In relation to what?

3 Use the problem of solid waste as an example of an area where RAO may have occurred for some people. Have students consider the following facts.

- The average person in Washington State disposes of 5.2 lbs. of garbage per day.[1]
- A thousand tons of uncompacted waste would cover a half-acre of land three feet deep.[2]



1 Washington State Department of Ecology, Solid Waste in Washington State, Feb. 1996, p. viii.

2 John Conroy, Ecology, Northwest Regional Office, Bellevue, 1983.

RAO is a likely response to a problem of this size.

4 Discuss the possible solutions to the problem of waste.

- Who, ultimately, is responsible for solving our solid waste problems ---- county, state, or federal government; those we elect; only those who generate the waste; you?
- Should government strictly regulate disposal of all types of household waste? Should government force people to recycle?
- Is it reasonable to expect that individual action has a chance of solving a problem of this size?
- If not, what do you see happening? More and more land used for landfills? Massive contamination problems caused by these landfills? Increased ocean dumping? More resource recovery plants? Use of technology in a yet undiscovered way of handling waste?

Part II: Other Large Issues And Personal Responsibility

1 Ask students to identify other large economic/ political/ social issues they perceive they can do nothing about. Some examples might be:

- Nuclear war
- Hunger
- Industrial pollution
- Overpopulation
- Unemployment
- Inflation

2 Have students pick one of these topics or pick one you are currently studying, and list all possible solutions. Identify individual responses that can help solve this problem. Ask:

- How do individual solutions differ from large organized solutions (i.e., governmental or institutional efforts)?
- How do the benefits differ? Is there any good to be realized from an individual action even when it won't be sufficient to solve the problem?

3 What is the law's role in determining individual response to the problems? Can you think of any laws that demand or encourage personal or corporate responsibility?

- What legal problems might result from a law requiring people to aid accident or rape victims? (The "Good Samaritan" law in Washington State states that you cannot be held liable for civil damages for any action taken in good faith and not for compensation while trying to assist at the scene of an accident.)
- The manufacturers of Agent Orange, the defoliant used in the Vietnam War, were sued to establish responsibility for the alleged subsequent health effects of dioxin on veterans. Should the manufacturers have been held liable? (According to law, the federal government cannot be held liable for injuries sustained in war.)
- As a response to the enormous litter problem, do you think the Washington State law requiring litter bags in every car and a $50 minimum fine and/or litter pickup for persons convicted of littering has been effective?
- What responsibility do companies manufacturing hazardous waste have for its disposal? Should the government regulate disposal? What are the company's responsibilities if the wastes are discovered years later? Regulating businesses can be expensive. Who should pay for regulation ---- the government (which eventually means taxpayers), the consumers who use the products, the company itself?
- In terms of managing solid waste, should the state attempt to regulate behavior by laws such as the "Bottle Bill," which attempts to promote recycling by imposing a mandatory surcharge on all beverage containers?
- Should counties and cities enact "flow control" laws that strictly regulate disposal of waste? (Flow control measures are enacted to ensure a steady stream of waste to burn in resource recovery plants.)

4 Ask students to think of a large local problem about which they feel ---- "I really should do something about this," (e.g., your reaction to seeing hungry or homeless people in your city).

5 Did students do anything about the problem? Why? or Why not? If not, what keeps people from being the solution? What keeps them from taking that final step of action?

6 Are there any community problems you have helped resolve, even in the smallest way? If you have, what problems were solved? What benefits did you derive from participating in the solution (i.e., made friends, learned something, opened door for employment, gained satisfaction in doing something worthwhile, learned to approach problems in a positive, active way)? Compare your feeling of accomplishment to that of the man in "My Twenty Foot Swath"?

Part III: A Personal Responsibility Activity

1 Have the class identify a waste, litter, or recycling problem as the man in the article did, and determine what to do about it. The solutions may or may not be immediately obvious. Individual action you can take right now:

- Start source separation and recycling at home.
- Be a responsible buyer. Look for products packaged in reusable and recyclable containers.
- Compost waste.
- Speak up against litter! Report litterers to Department of Ecology Hotline, 1-800-LITTERS.

Bibliography

Lundberg, Kenneth V. "My Twenty Foot Swath." Covenant Companion. Chicago: Covenant Press (5101 N. Francisco Ave.), October 1982, pp. 8-9.

Washington State Department of Ecology, Solid Waste in Washington State, Fourth Annual Status Report, Including 1994 Recycling Survey, Feb. 1996, Publ. # 96-500.

My Twenty Foot Swath

Kenneth V. Lundberg

[Covenant Companion, Reprinted by permission of the Covenant Press]

"I worried so much about world hunger today, that I went home and ate five cookies." Did personal or global problems ever become so overwhelming that you were immobilized, or driven to some action that actually aggravated the problem? Have you experienced such frustration about the hopelessness of solving the problems of poverty, environmental pollution, or human suffering that you could avoid it only by deciding that you were powerless to do anything about their alleviation? This is called Responsibility Assumption Overload (RAO). Here's how I dealt with this feeling.

I park my car away from my building at work. That way I get both exercise and a parking space, as everyone else competes for spots next to the entrance. My morning and late afternoon strolls take me on a stretch of lawn between the tennis courts and the soccer field, and across an occasionally used softball diamond. The lawn is twenty feet wide, more or less. Soft and green, it was originally very littered. Tennis players discard tennis ball containers (and their flip-tops), worn out sweat socks, broken shoelaces and energy candy bar wrappers. Soccer game spectators leave behind beer bottles and junk food cellophane.

In my early days it disgusted me, and my thoughts centered on ways of correcting the situation: writing letters to the campus newspaper (no doubt totally ignored); campaigning for anti-litter regulations (who would enforce them?); organizing a "Zap-Day" cleanup (leaving 364 days for littering). All my noble efforts would have demonstrated my indignation, raised my blood pressure, and attracted attention, but they would not have changed the appearance and/or condition of the area.

So, I decided to take ownership. I would be the solution. I did not tell anyone of this; it was probably against some rule or another. I decided that I would be responsible for the environmental quality of this twenty-foot swath. I did not care what other parts of the campus were like. They were someone else's problem. But each day, going from and to my car, I picked up litter.

At first, it was as much as I could conveniently carry. Then I made a game of it, limiting my picking to ten items each way. It was an exciting day when I realized I was picking faster than "they" were littering. Finally, the great day arrived when I looked back on my twenty feet of lawn - now perfectly clean.

Where did I put the litter? At first, I brought it into a wastebasket in the building, or took it to the car to bring home. Then a curious thing happened. One day, large orange barrels appeared at each end of my swath. Someone in maintenance had become my silent conspirator - periodically emptying and replacing the barrels. He, too, knew the wisdom of keeping a low profile about it all.

I've done this for several years now. Has general campus appearance changed? Not much! Have litterers stopped littering? No! Then if nothing has changed, why bother?

Here lies the secret. Something has changed. My twenty-foot swath - and me! That five minute walk is a high spot of the day. Instead of fussing and stewing and storing up negative thoughts, I begin and end my workday in a positive mood. My perspective is brighter. I can enjoy my immediate surroundings - and myself - as I pass through a very special time space.

"It is better because of me. I am better because of "it." "We" enjoy the relationship. Maybe, even, "it" looks forward with anticipation to my coming.

With a brighter outlook, I have learned a lot of things that would have gone unnoticed. For instance, I have learned that tennis players grunt a lot. There

seems to be some correlation between the quality of the grunt, especially on serve, and the quality of one's game. Maybe I have discovered the secret of the game. I have also learned that soccer players curse a lot, but there does not seem to be any correlation between that ability and soccer skills. I have even learned that most soccer spectators, at least at my college, come to eat, drink, and talk - not to watch the game.

My learning - and the twenty-foot swath - does not stop at the building door. There is an important principle that follows wherever I go. I cannot solve man's inhumanity to man, but I can affirm, with a smile and a word of appreciation, those who feel burdened by the need to work at lowly jobs. I cannot right the imbalances of centuries of discrimination, but I can "lift up" someone who feels the weight of a poor self-image. I can treat women as equals without solving the problems of sex discrimination. I can seek out the social and economic litter in my own "twenty-foot swath" without demanding of myself that I "clean up the whole world."

I now practice a discipline of leaving each time-space capsule of my life a little better than when I entered it. Each personal contact, each event, each room I enter becomes a small challenge. I want to leave it improved, but more important, I am responsible to myself to be improved; and thereby, maybe - just maybe - my having been there will make life better for someone else.

I am becoming more and more disenchanted and suspicious of revolutionaries, crusaders, militants, and do-gooders. Many, if not most, seem to be more concerned about being right than being loving or effectual. The zealot, no matter how well-intentioned, often leaves a trail of wounded people while in pursuit of the cause.

Is this all too myopic - shutting one's eyes to the greater concerns? It does not need to be! I now have a twenty-foot swath. Next year it may be forty, or sixty, or eighty feet wide. Ten talents were not required of him who had been given only one. Too many people stumble by taking on causes too great for their level of discernment and discipline. They need to begin to catch the vision of the important promise, that the meek shall inherit the earth, not the indignant or frustrated.

Deciding What To Do

A Simulation of a Public Hearing: Siting A Solid Waste Disposal Facility

Subjects: Social Studies, Government, Contemporary Problems, Environmental Studies, Science

Grades: 9-12 (Science, Technology, and Society Unit)

Teaching Time: Two or Three Class Periods, Plus Research Over Several Weeks

Focus: Science, Technology and Society, Solid Waste Management, Decision-Making Processes

Rationale

Management of solid waste in general and siting a garbage disposal facility in particular are complex and controversial public decisions. In the decision-making process, a wide range of perspectives and values come into play.

The decision-making process used in managing solid waste is illustrative of the process used to decide other difficult public issues.

Learning Objective

Students will:

- Understand the complexity of managing solid waste.
- Realize the wide range of perspectives and values involved in making decisions about solid waste.
- Understand that there is no one "right" or "correct" answer to most of the serious problems facing our society.
- Learn an interdisciplinary decision-making process through role playing.

Teacher Background

Read and review the "Scenario" and "Roles" included. Review the introduction in the Hazardous Waste section for some of the issues surrounding disposal of both solid and hazardous wastes, p. 197.

See under "Resources for state regulations for the siting of landfills and incinerators. To supplement your materials have students collect information from newspapers, television news shows, and magazines related to siting landfills or incinerators.

Materials

- Scenario and role description
- Sample hearing agenda
- Newspaper and magazine articles from your local area on problems in the management of solid and/or hazardous waste

Learning Procedures

The class will conduct a simulated refuse disposal siting/solid waste management hearing with class members taking the parts (see description) of various participant's roles in the waste management decision-making process. The disposal facility under consideration includes options for an incinerator only, landfill(s) only, or both. Other pertinent issues not explicitly on the hearing agenda, but which have direct or indirect bearing on the waste management problem as a whole, are:

- Waste prevention and reduction and what can be done to encourage it especially in industry.
- Recycling and the role it should play in the overall waste management plan.

- Reducing industrial waste through the establishment of waste exchanges or treatment facilities.

These issues and others are part of the many questions facing communities and government agencies the world over as they grapple with the cumulative effects that result from our "throwaway" culture.

1 Distribute copies of the scenario and a role description to each participating class member in the simulation. For best results, role descriptions should not be shared by different groups. Tell the students that the problem closely parallels the actual situation in a number of Washington State counties. The class's job is to understand and discuss the solid waste problem and come up with solutions. The emphasis should be on possible alternative solutions and not just a single answer to the problem.

2 Choose a student to serve as County Commissioner/Hearing Examiner. Then choose other students to fill the roles described on pp. 178-183. You may wish to assign some roles to more than one student. For example, have two Journalists; one from a large newspaper and one from a smaller weekly publication; or one from the daily paper and one from a magazine. If the class is large enough, let some of the roles be assigned to two or three students who will each study and research a particular aspect of their roles' concerns about the county's disposal strategies. Not all the roles are necessary, but the "hearing" will work best if at least the first six or seven parts are included.

3 An alternative approach is to assign the more technical and science oriented roles, such as Scientist Expert, Toxicologist, Incinerator Vendor, etc., to a Chemistry and/or Biology class, while giving the other roles to a Social Studies class. The final hearing could be held in two sessions, one for each class. Have the Chemistry class do the activity, and "Making Acid Rain," p. 29.

4 Explain to students that this simulation is not meant to represent any actual public hearing or governmental hearing process, but that many public bodies are required by law to solicit input and comment on complex projects that can affect human health and environmental quality.

5 Have students prepare to play their roles realistically and convincingly by having them contact their real counterparts in your county. Encourage students to add substance and appropriate detail to their roles.

6 Hand out the sample hearing agenda or prepare a similar one of your own. Assign a specific date or dates for conducting the hearing. Encourage all the participants to come prepared with either questions or a brief presentation as indicated on the agenda. When the hearing takes place, have that part of the class not playing specific roles serve as the County Council, both questioning the hearing participants and, in the end, reaching a decision about what to do with all that garbage.

Extended Learning

1 Attend a local public hearing or one of the public involvement opportunities sponsored by the Department of Ecology's Information and Education Office. Call 360-407-6488 or write to them at P.O. Box 47600, Olympia, Washington 98504-7600 to learn when the next event near your locality will be held.

2 Invite recyclers, environmental activists, solid waste engineers, garbage haulers, reporters, county commissioners, etc. to your class to describe the role each plays in dealing with your county's solid waste.

Resources - *See the following state regulations for the siting of landfills and incinerators.*

Chapter 173-351 WAC Criteria for Municipal Solid Waste Landfills
Chapter 173-306 WAC Special Incinerator Ash Management Standards

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The Scenario

County population is growing rapidly. The volume of solid waste produced in the county is growing even more quickly. Recent federal and state regulations have outlawed open dumping, so all the old dumps have been closed. To protect human health and the environment, safeguards must be built into any new sanitary landfill, but this makes it very expensive to construct and it must be monitored throughout its use and for many years after. People have been attracted to living in the county because of its beautiful semirural character and thus are very sensitive about environmental degradation or property devaluation that may possibly result from a landfill or large-volume garbage burner being built nearby.

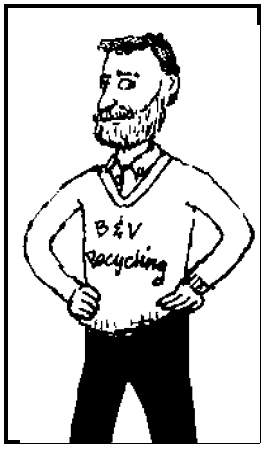
The county public works department, which has responsibility for proper disposal of all municipal waste generated within the county, is increasingly concerned about the growing amount of waste and is considering both a mass burner and/or a new landfill. The existing landfill is filling up fast and, given the long lead time needed to site and build a replacement, a decision about what to do with the county's waste must be made soon.

Roles

Environmental Activist

You feel strongly that more recycling could be done in the county. You think the county should require home source separation of recyclable materials such as aluminum, glass, and newspapers and that private or public garbage haulers should be required to provide separate pickup for recyclables. You'd like the county to institute a county-wide, per-can garbage collection fee schedule that allows as little as one pickup a month. You want the county to fund public education programs in recycling; programs both for citizens' groups and schools.

You oppose the construction of a resource recovery, waste-to-energy incineration plant. As an environmentalist, you are concerned about the effects of incinerator emissions on air quality. You understand that a mass burn incinerator will require huge amounts of refuse to operate efficiently and thus discourage recycling efforts, while at the same time presenting problems in disposing of the toxic fly ash generated. Nevertheless, you are aware that a landfill could cause considerable environmental damage to the land, air, and water.



Recycler

You became involved in recycling a long time before concerns about environmental degradation were first voiced. Profits have never been large and the markets for recyclables have never been particularly stable or reliable. Nevertheless, the satisfaction of knowing that your job is part of the solution and not part of the problem has always made the hard work and long hours necessary to survive more than worth it. After 20 years, you have carved out a secure market for your business and you are looking forward to relaxing a little, while letting the younger generation carry on the day-to-day work.

You are worried that a mass burn, waste-to-energy type incinerator will cut the bottom out of the recycling market. Although you would like to see the city institute mandatory recycling and source separation, you recognize that your own business is probably too small to compete with the large waste management firms that the city would most likely end up contracting with for such a mandatory program. You are gratified that at last recycling is becoming a "big business" and thus respectable, but you are angry and a little bit frightened that you and your hard-earned business will get lost in the shuffle.

Garbage Hauler

You own a garbage collection company. Your company is licensed by the state and franchised by the county. Your prime concerns are providing good service to a rapidly growing number of customers and keeping costs down. You are also concerned about county and state regulations of your business. In recent years, more of the task of running your business has been taken up with government forms and "red tape." You are concerned about the prospect of the county telling you how to set your collection fees, how the garbage itself must be picked up, and where you have to take it once it's been collected.

Spokesperson, Homeowners' Group

You are worried that the county/city may be planning to build a landfill or an incinerator near your home. You are worried about the roadway litter you're afraid would result. You are also concerned about the increase in the rat, crow, seagull, and wild dog population that a landfill may bring. You are also worried that household hazardous wastes dumped into the landfill will generate toxic leachate that could contaminate your drinking water. You are angry when you think that a landfill or large-volume garbage burner may decrease the value of the house and land you've worked so hard to own.

As the cofounder of the Ratepayers Against Incinerators/Landfills (RAIL) you have been asked by the organization to present RAIL's concerns at the upcoming hearing. You realize, however, that it is not enough to protest a specific site, but that appealing and feasible alternatives must be presented. For this reason your organization has come out in favor of increased recycling.

County Public Works Engineer

Your county department has responsibility for disposing of all waste generated within the county. You also have responsibility for meeting federal and state regulations governing the disposal of waste. Part of your job is to design and build waste facilities such as landfills and mass burners. At the same time, you are required to ensure that these disposal facilities do not create hazards for the environment or human health. A great deal of your energy goes into selecting and evaluating possible disposal sites and advising county commissioners/council members on technical aspects of solid waste management. You are becoming alarmed at the rate of growth of the county's volume of solid waste and, probably most acutely, realize the enormity of the county's solid waste problem. You ask yourself: "Where is all this stuff going to go?"

Lately, however, much more of your time has been taken up with public relations, dealing with the concerns and sometimes anger of citizens who question or challenge county solid waste policy or decisions. You believe that citizens need to be better informed about some of the scientific and technical issues that are part of deciding what's the best option. You are especially concerned that the press is playing up some of the more sensational but remote dangers associated with incinerators and landfills. It seems that no matter how well you document the safety of a waste-to-energy incinerator or a landfill site, the papers always play up the negative aspects.

County Commissioner/Council Members

Your job is to make the final decision about how to deal with the county's growing volume of solid waste, while taking into account the needs and interests of a broad range of county citizens and businesses. You have to understand both the technical information provided you by the public works director and the anxiety of homeowners who feel threatened by the possibility of a landfill or mass burner in their area. You try to be pragmatic and fair. You also want to get reelected to office.

Your role in the hearing is to conduct a landfill siting/solid waste management discussion by calling on and questioning the other role players. It is also your responsibility to seek the input of other county commissioners/council members and interested citizens. It is your responsibility to conduct an orderly and productive meeting. This means that each participant should be treated equally and that all viewpoints are given a fair hearing.

County Citizen
You lead a busy life. You like the convenience that some packaged and processed foods give you, though you are sometimes bothered by the amount of packaging left over. You know your county is growing rapidly but have been more concerned about other consequences of growth such as crime, crowded highways, and air pollution than you have been about an increase in garbage. Frankly, you'd like to throw your trash in the garbage can and forget about it, even though you know in the long run that your children or grandchildren may end up paying for it with a less healthy environment.

You're paying the garbage hauler and the county taxes to take care of trash for you. You don't feel you have enough time in your day to fool around with the trash, separating it for recycling.

Journalist
Your job is to ask hard questions, understand the important issues, and report accurately the decision-making process. Time and time again you've been assured by elected officials that the city has its garbage problem under control, only to learn later, after careful digging, that the plans made have proved to be inadequate for the mounting garbage generated daily through expanded growth. When you ask about safeguards for environmental and human health, the engineers and planners present seemingly endless numbers and graphs all purporting to establish the safety of the sites being proposed for the disposal facility.

Just this past week you received a tip that the father-in-law of one of the county commissioners has a substantial investment in the company that is proposing to build and manage a mass burner, waste-to-energy incinerator. Before going public with this information, you will have to spend considerable time verifying its accuracy – time you would much prefer spending on researching substantive issues.

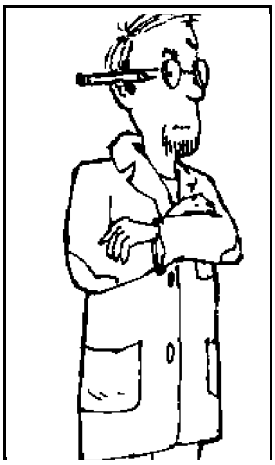
Incinerator Plant Vendor
You believe that incineration is the best solid waste management method available. As an engineer with many years of experience in waste management and chemical processes, you know that the technology for safe incineration is already available and you don't understand why some citizens are fearful and unwilling to trust your professional judgment. If asked, you would have no qualms about having an incinerator site next to your property.

You want your company to be selected for this county's contract. Your boss has promised you an especially attractive bonus if you can "land" this one. You also know that waste incinerators, under the right conditions, are good opportunities for investors.

Regulatory Agency Official
You have been assigned by your agency to carry out state law as mandated by the State Legislature. Your responsibility is to write enforcing regulations that will protect public health and the environment yet still provide practical and economically feasible waste management facilities. You are sensitive to the public's view of you, yet you know that there is no perfect set of regulations that will please all the parties. From your past experience as a field inspector, you know that strict enforcement of the law doesn't always lead to the desired result of a safer environment. You are sometimes as frustrated as the public by the legal requirements built into the regulations as safeguards against unjust government actions, but which are all too often exploited by a few "bad eggs" at the expense of the many. It is sometimes hard to remember that most

individuals and businesses are honest and want to comply with the law, especially as it relates to the environment.

You have been asked to attend this hearing to explain the current state and federal regulations and how they affect the county's proposal for siting a disposal facility. You expect to be questioned closely by both citizen and industry groups.



Scientist-Expert

You are a professor of geology at a nearby university specializing in hydrology, the study of water movement in the earth. Your research has focused on groundwater flow and the scientific study of the problems associated with contamination from human activities. Your publications have appeared in numerous journals and your scholarly expertise has been acknowledged by many professional organizations throughout the world. As your reputation as an expert has grown, you have been called on to speak at a growing number of public hearings and workshops throughout the state, including testimony at legal trials on the safety of various disposal options with respect to potential and actual groundwater contamination. You know as a scientist that there is no such thing as certainty, especially in a field like geology where most events are measured in millions of years, and actual experimental verification is possible only on a limited basis. Nevertheless you find yourself being asked to give "yes" or "no" answers to questions that scientific and technical knowledge can never provide.

The county commissioner has asked you (for a fee) to examine the county's plans for disposal and to provide a brief report discussing the impacts that each option might have on the water supply now and in the future. At present the data available and current scientific models can only suggest in a most sketchy fashion what these impacts might be. You are worried that, because of this, each faction will seize upon those parts of your presentation that most closely support its position and then point to you as proof of the "truth" of its claims.

County Attorney

The district attorney's office reviews all the county plans to ensure that the county does not violate any of the many governmental regulations that inevitably cover any large-scale plan. Projects with the potential for environmental harm and/or human health effects are especially complex, involving as they do both technical and political issues. You have been assigned the job of monitoring the legal aspects of the county's waste management plans.

As a recently graduated law student from a prestigious university, you have been on the job for about a year. You feel you are ready to tackle a "real" assignment instead of all the routine jobs you've been handed during the past year. Anxious to establish yourself as a top-notch lawyer, you welcome this assignment as the first step in your career as a public official. Like many other young lawyers you have political ambitions, and you know how crucial it is to perform well on this, your first big assignment.

Your boss, the district attorney, is particularly concerned about the threat of lawsuits and other legal actions from various special interest groups, such as nearby homeowners, industry organizations, and environmental activists.

Private Consultant

The county hired the firm you work for to study the various options for a garbage disposal facility. You have been part of the team that carried out the necessary research and your particular expertise is in the area of stack emissions in incinerators and other industrial combustion facilities. Your supervisor is out of town this week and you have been tapped to represent the firm if any questions arise concerning the recommendations that were

made to the county as part of your firm's final report. Since a mass burner was included as part of the recommendation, you expect to be sharply questioned on this aspect of the overall strategy your company proposed.

Toxicologist

You work at a federal government laboratory studying the effects of chemicals on mice and rats. Most of your research is directed toward determining whether certain chemicals can cause cancer in humans and animals. The main research tool for doing this is to expose special strains of rats and mice to substances and observe whether, or at what dosages, tumors develop. You know that many people are doubtful about relating results from mice to humans. Skeptics point out that experimental animals are exposed to high doses of substances at levels not commonly found in a normal living environment. You, however, know that in order to extrapolate to the low dose exposures that are typical of human environments, the 50 to 100 rats and mice must ingest enough toxin to produce a statistically significant number of cancers. Estimates of a substance's cancer-causing potency are based on the extrapolation of the experimental animal results to low doses.

Several environmental organizations have expressed concern about production of dioxins by the incinerator, either as smokestack emissions in the air or as part of the fly ash that must be disposed of. Dioxins are a class of chlorinated organic compounds produced as by-products in the production of herbicides and other industrial products. At least one dioxin, TCDD, is the most potent carcinogen (cancer-causing substance) known in mice and rats. The evidence for its cancer production in humans is not, however, established, and scientists disagree as to what exposure levels are safe.

Farmer/Agriculture Representative

Your family has roots in the area that stretch back to the early pioneer days more than a hundred years ago. You have watched the county seat grow from a small town to a medium sized city. You are concerned about the rapid growth and its effects on prime agricultural land. In your view, building a mass burner will encourage more growth and you know that your family farm may ultimately be threatened by this growth. Taxes continue to increase and you have farmer colleagues who have been forced to sell their acreage due, in part, to rising property taxes. You feel strongly about your stewardship of the land and are worried that your family's long-time ties to the land may be broken.

Real Estate Developer

You believe that progress must necessarily include some environmental disruption, but that the economic growth for the area far outweighs the short-term pollution of a "few" streams or the conversion of some prime agricultural land for suburban housing and shopping centers. If most environmentalists had their way, the county would soon stagnate from the many regulations and restrictions that stifle growth. You are convinced that the expansion now under way must not be interrupted and that desirable "high tech" industries can be attracted to the area only if they can be assured that there are adequate waste disposal facilities.

You believe that growth is inevitable and that, even if there are some minor problems now, scientists and engineers will come up with the necessary technology in the future to solve them. Sure, in the past, some mistakes were made, but there are plenty of safeguards built into the law now and, besides, it's always been necessary to "break a few eggs to make an omelet." You believe that a waste-to-energy incinerator, with its capability to generate electricity, is necessary for the continued economic health of the county.

Chamber of Commerce Representative

You have been a member of the local business community for 20 years. Your business has been slowly growing after a struggle to make ends meet for the first 10 years. However, the recent recession has caused you great concern: will you be able to meet the costs of college education for your two teenage children? A waste-to-energy plant would bring cheaper electrical power rates and build an economic base in the county. Recycling efforts could bring in a few jobs, but larger companies outside the area are already prepared to initiate large-scale recycling efforts. A new landfill might cause a reduction in business opportunities, tourism, and residential growth.

Public Hearing On Proposed Municipal Refuse Disposal Facilities

Agenda

I. Opening Statement - *County Commissioner*

II. County Proposals - *Public Works Engineer*

- **A.** Combination Incinerator and Sanitary Landfill
- **B**. Waste Reduction/Recycling with Smaller Landfill and Incinerator
- **C**. Long Distance Hauling to Eastern Washington or Eastern Oregon
- **D**. Question Period

III. Expert Reports

IV. Citizen Testimony

- **A.** RAIL
- **B.** Organizations

V. Industry/Business Testimony

VI. Final Summarization and Questions

VII. Conclusion and Vote - Commission Members

VIII. Report of Proceedings by the Two Journalists

Landfills Then And Now

Landfills Then

Prior to 1969, no solid waste statute existed in Washington State. A hole was dug, and garbage was placed in the open pit or dump. The traditional sanitary landfill designs which were initiated in 1969 in Washington State placed refuse no deeper than 5 feet above the high ground water level to prevent water leaching into the landfill. To prevent water percolation down through the refuse, a fairly impermeable cover material was used and the surface was kept fairly level. The most suitable cover material was a sandy loam about half sand and the rest equal parts of silt and clay. Refuse was spread in two-foot layers and immediately compacted. Each day's layer of refuse was covered by a six-inch layer of earth. When a section of the landfill was filled to capacity, a final two-foot compacted layer of earth covered the area. Grass was planted in the area to prevent erosion.

Methods developed to avoid pollution of surface water and ground water were a gradual sloping of the landscape, constructing diversion ditches, and installing collection pipes. Landfill operators used graders, bulldozer tractors, and landfill compactors for sloping, filling, compacting, and covering the refuse. Most older landfills had no leachate collection system, no methane gas collection system, no ground water monitoring wells, and no protective liner at the bottom of the landfill.

Landfills Now

Landfilling standards as identified in WAC 173-304-460 were established in 1985. The following major standards apply to facilities which dispose of solid waste in landfills except for inert and demolition wastes. The minimum functional standards guide performance, design, maintenance and operation, and closure and postclosure.

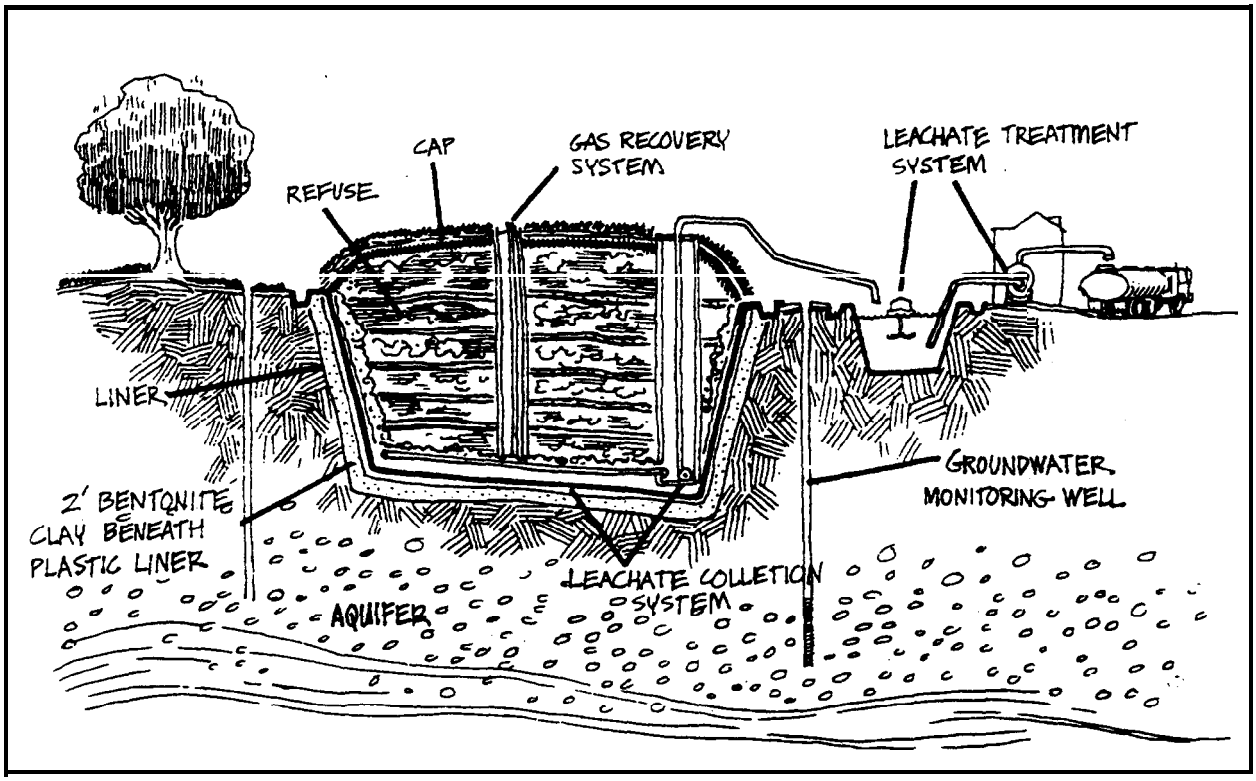
Performance standards protect ground water, air quality, and surface waters. Design standards minimize liquids admitted to the active areas of landfills, provide leachate collection systems, and install liners or an equivalent design alternative. Arid areas (less than 12" annual precipitation) use a vadose zone moisture monitor. The vadose zone is the area in the earth's crust above the ground water level but below the surface. The design standards also include a 100 year floodplain location for the landfill (designed for anticipation of the worst storm each 100 years). Some other requirements are adequate access roads, fencing around the site, and a series of ground water monitoring wells checking for leachate in the water or for subsurface gas movement.

Maintenance and operating standards require dust control, no open burning of garbage, litter collection, compaction, and daily cover (with some local health department exceptions). They also provide facilities for recycling by the general public, and maintenance of the ground water monitoring system.

Closure standards require written estimates of the cost of closure and postclosure monitoring and maintenance in accordance with the closure and postclosure plan(s).

The drawing on p. 296 is based on the design for the new section at Cedar Hills Landfill in King County. The landfill at Cedar Hills has over 40 gas and ground water monitoring wells. It has two holding ponds for collection and treatment of leachate. A successful seagull control program has been implemented by stringing wires on poles around the landfill site. The Cedar Hills design exceeds the standards required by law.

A Modern Landfill



Making A Mini Landfill

Subjects: Science, Social Studies
Grades: 3-10
Teaching Time: Step A - 20 Minutes; Step B - 20 Minutes; Step C - 20 Minutes
Focus:

Rationale

Products that end up as waste are made from a variety of natural resources. Because of differences in composition and biodegradability, much of what we now throw away could be composted or recycled.

Learning Objective

Students will:

- Understand the meaning of the terms "organic," "biodegradable," "renewable," and "nonrenewable resource" and why each kind of waste should be handled in a particular way.

Teacher Background

See the Solid Waste Introduction for landfill information, p. 79.

For examples of model landfills, see the activities "Waste And Water," p. 213, and "Landfills Then And Now," p. 185.

Materials

- Four large clear glass jars
- Soil
- Wooden spoon
- Four sample garbage pieces
- Labels
- Enduring litter poster

Pre & Post Test Questions

1. What does "biodegradable" mean?

2. What is the difference between a dump and a sanitary landfill?

3. Which natural resources are renewable? Which are not? Why?

4. What are four items you use everyday you could recycle?

Learning Procedure

Step A.

1 Ask students how garbage is disposed of. Discuss: The proper disposal method for each component of garbage should be determined by its natural resource content.

2 Show examples to students and outline four basic categories of solid waste:

- Organic (e.g., potato peelings)
- Renewable resource/recyclable (e.g., newspaper)
- Nonrenewable resource/recyclable (e.g., aluminum can)
- Nonrenewable resource/hard to recycle (e.g., styrofoam cup)

3 Have students draw the life cycle of these items from raw material to disposal in a landfill.

4 To save natural resources and to reduce solid waste, from which of these four categories would you try to buy products? Which category of products would you avoid? Taking each of the examples listed (potato peelings, newspaper, aluminum can, styrofoam cup), think of ways to avoid disposing of them in a landfill.

Step B.

1 Ask students to: Fill four glass jars with the same amount of soil. Each student may wish to have a jar.

2 Label each jar with one of the four category headings.

- Organic
- Renewable/recyclable
- Nonrenewable/recyclable
- Nonrenewable/hard to recycle

3 Put an appropriate small sample in each jar. Cover with soil and dampen with water. Leave the lids off.

4 Observe and chart what happens over two to three weeks. Discuss the condition of the various kinds of waste. Discuss biodegradability. Compare the mini landfill to real landfills. From your observations, discuss the potential environmental problems associated with waste in landfills (leachate contamination of water, smell, methane gas, garbage truck traffic, litter, scavenging birds and animals scarcity of landfill sites, cost, loss of natural resources and energy, etc.).

Step C.

1 At the grocery store, while purchasing the family's groceries, have each student keep a record of the purchases by dividing them into the four solid waste categories.

2 In class, have students discuss which items they should eliminate from their shopping list or how they can substitute nonrenewable and nonrecyclable items with items that use renewable resources and generate less trash for the landfill.

Step D.

1 Make a model landfill; see activity "Waste and Water," p. 313.

2 Place examples of photodegradable, biodegradable, and nondegradable plastics in the landfill.

3 Monitor the degradation changes in the plastics for three months.

4 After monitoring the results for plastics, repeat the experiment with various grades of paper or other organic materials.

Extended Learning

Take a field trip to your county's landfill, or invite your county's solid waste manager to speak to the class.

Resources -

Video Tapes: Trash Monster. California Solid Waste Management Board. 1980. 12 min.

Wizard of Waste. California Solid Waste Management Board. 1980. 12 min.

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CHART FOR "MAKING A MINI-LANDFILL"

— Example —

Product	Chart for "Making A Mini-Landfill" Step B. What type of resources were used for the packaging?				Is this product necessary?	Is there an alternative?	How could this product be better packaged to save resources and energy?
	Organic	Renewable/ Recyclable	Nonrenewable/ Recyclable	Nonrenewable/ Nonrecyclable			
Plastic Milk Jug					Yes	Yes	In glass or waxed cardboard.
Chewing Gum		Part	Part	Part	No	Yes	Package in biodegradable paper
Vegetable in Tinned Can			Where a market exists		Yes	Yes	Can the vegetables yourself in reusable jars. Biodegradable paper package for frozen foods.
Pop Aluminum Can					No	Yes	Glass, also returnable glass.

CHART FOR "MAKING A MINI-LANDFILL"

Product	Chart for "Making A Mini-Landfill" Step B. What type of resources were used for the packaging?				Is this product necessary?	Is there an alternative?	How could this product be better packaged to save resources and energy?
	Organic	Renewable/ Recyclable	Nonrenewable/ Recyclable	Nonrenewable/ Nonrecyclable			

Analyzing Ash

Subject: Chemistry
Grades: 9-12
Teaching Time: 40 Minutes
Focus: Incineration, Hazardous Waste

Rationale

Incineration solves some of the environmental problems of garbage but poses others; in particular, what to do with toxic fly ash.

Learning Objective

Students will:

- Learn where metals go in the process of waste incineration.
- Learn how relationships of mass and volume change as paper is burned.

Teacher Background

Review the background material on the student lab sheets. In this demonstration, the total mass and volume of the paper will decrease because much of the paper is converted to gases (CO_2 and H_2O vapor), which are released into the atmosphere.

Warning: It is necessary for the safety of the class to have a lab with a hood and a fan to preserve the quality of the air.

Materials

- The materials and equipment needed are listed on the Student Lab Sheet, p. 193.

Pre and Post Test Questions

See the questions at the end of the Student Lab Sheet.

Learning Procedures

1 Tell students that this experiment will investigate what happens to metals when they are mixed with other materials and burned.

2 Have students work in pairs. Hand out Student Lab Sheets to each pair.

3 Go over the laboratory procedure with the students as given in the Student Lab Sheet instructions.

4 Have students do the experiment and fill in the blanks on their Lab Sheet.

5 When all the students have finished, **Ask:** "Where did the iron metal go when the paper was burned?" (It's in the ash.) Discuss with students the implications of the metal remaining in the ash as detailed in the background material in the Student Lab Sheet. Use the questions at the end of the sheet.

Extended Learning

1 Test for the presence of iron in raisins, by repeating this experiment. Use raisins and a crucible; no need to add $FeCl_3$. (Be sure to flatten the raisins.)

2 Develop demonstrations to test for the presence in ash of the hazardous heavy metals listed in the background material in the student handout. Or, assign groups of students a different heavy metal and have them research the methods used to test for these metals.

3 Have students determine differences in the solubilities of heavy metal oxides when changing the pH.

4 Invite a speaker from the Department of Ecology or your municipal engineering or waste disposal department to speak on the chemistry involved in the incineration of solid and hazardous waste.

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Analyzing Ash - Student Lab Sheet

Name_____ **Date**_____

Experimental Objectives

1. Demonstrate where metals go in the process of incineration.
2. Demonstrate how the relationships of mass and volume change as paper is burned.

Background

Incinerating waste reduces input waste volumes 70 to 90 percent depending on how much source separation has been done and the type of incineration (i.e., mass burn, sludge only, etc.). The resulting ash is of two types: bottom ash and fly ash. Bottom ash is relatively inert and harmless. But toxic heavy metals in waste concentrate in fly ash. Thus, fly ash disposal becomes an environmental and public health concern.

During high temperature incineration, metals in garbage form particulates that may be trapped by pollution control devices and end up in fly ash residue. Some heavy metals may cause cancer if ingested in particulate form in sufficient concentrations. They may also leach into water and poison aquatic organisms. These metals are: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

Garbage contains some of these heavy metals. Thus, effective pollution control to capture heavy metal particulates and safe disposal of fly ash become important environmental and public health concerns.

In 1994, five waste-to-energy facilities/incinerators in Washington State burned 421,626 tons of solid waste. Of that amount, 7,134 tons was identified as woodwaste at the Inland Empire Paper facility in Spokane. This is the only incinerator that does not burn municipal solid waste. The amount of solid waste statewide that was incinerated has remained stable (10 percent) for the past three years. One of the municipal solid waste incinerators in Skagit County closed in 1994.

For waste-to-energy facilities or incinerators that meet both the chapter 173-304 WAC and chapter 173-306 WAC, the ash generated from the facilities must be disposed in a properly constructed ash monofill. There are four remaining energy recovery/incinerators that meet these criteria. All of the ash (113, 271 tons) from those facilities is disposed at the ash monofill at the Roosevelt Regional Landfill in Klickitat County.[1]

Materials

- Ruler
- Balance
- 250 or 400 ml beaker
- Glass stirring rod
- Paper and matches
- Small paint brush
- KSCN (0.1 M) solution
- $FeCl_3$ (0.1 M) solution
- HCl (0.002 M) solution

1. Washington State Department of Ecology, Solid Waste in Washington State, Feb. 1996.

Laboratory Procedure

1 Using one full sheet of used notebook or typing paper, crumple the paper as tightly as possible. Weigh and record the following:

a. Mass of beaker_____

b. Mass of paper _____

c. Mass of beaker and paper _____

d. Measure the diameter, d, of the crumpled paper _____ cm.

e. Calculate the volume of the paper ($TTd^3/6$) _____ cm^3.

2 Unfold the paper enough to paint on several stripes of $FeCl_3$ solution. The "Fe" in the $FeCl_3$ represents the metal (iron) in this garbage.

3 When the solution is dry, recrumple the paper and burn it in the beaker.

4 Use a glass stirring rod to reduce the ash to its smallest volume. Spread the ash evenly on the bottom of the beaker.

a. Measure the depth of the ash _____cm.

b. Calculate the volume of the ash (TTr^2 x depth) _____cm^3. (where r is the radius of the beaker)

c. Calculate the percentage reduction in volume _____

5 Weigh the beaker and ash again.

a. Mass of unburned paper and beaker _____

b. Mass of ash and beaker _____

c. Change in mass _____

d. Calculate the percentage change in mass _____

6 Add 2 ml of dilute HCl (0.002 M) to the ash.

7 Add 2 to 4 drops of KSCN (0.1 M) solution to the acidified ash. The resulting deep red color indicates that the metal iron has remained in the ash.

Preparation of Solutions - Procedures

1. Ferric chloride($FeCl_3$) - 0.1 M solution
   a. Weigh out 2.7 grams (g) of $FeCl_3$.

   b. Dissolve the $FeCl_3$ in 100 ml of distilled water.

2. Potassium thiocyanate(KSCN) - 0.1 M solution
   a. Weight out 0.97 g of KSCN.

   b. Dissolve this in 100 ml of distilled water.

   c. WARNING! Potassium thiocyanate is poisonous. Students should wash their hands thoroughly after use. Call poison control or physician if taken internally.

3. Hydrochloric acid(HCl) - 0.002 M solution
   a. Using stock solution of HCl, add 20 ml of HCl to 80 ml of distilled water. This results in 100 ml of 0.02 M HCl.

   b. Use 10 ml of 0.02 M HCl made above and add this to 90 ml of distilled water. This will produce 100 ml of the desired 0.002 M HCl.