Where Does the Trash Go?

CONTENT AREAS

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

OBJECTIVES

Students will…

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

MATERIALS

For the class

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

For groups of 2 or 3 students

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

For groups of 3 or 4 students

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

TIME

Two periods
45 minutes each

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

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

PROCEDURE

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

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

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

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

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

QUESTIONS

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

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

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

c. Which method produced useful by-products?

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

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

EXTENSIONS

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

Where Does the Trash Go?

COMPOSTING

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

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

RECYCLING

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

Recycling Rates

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

[1]EPA and various industry sources

[2]Porter and Associates

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

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

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

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

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

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

INCINERATION
or Waste to Energy

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

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

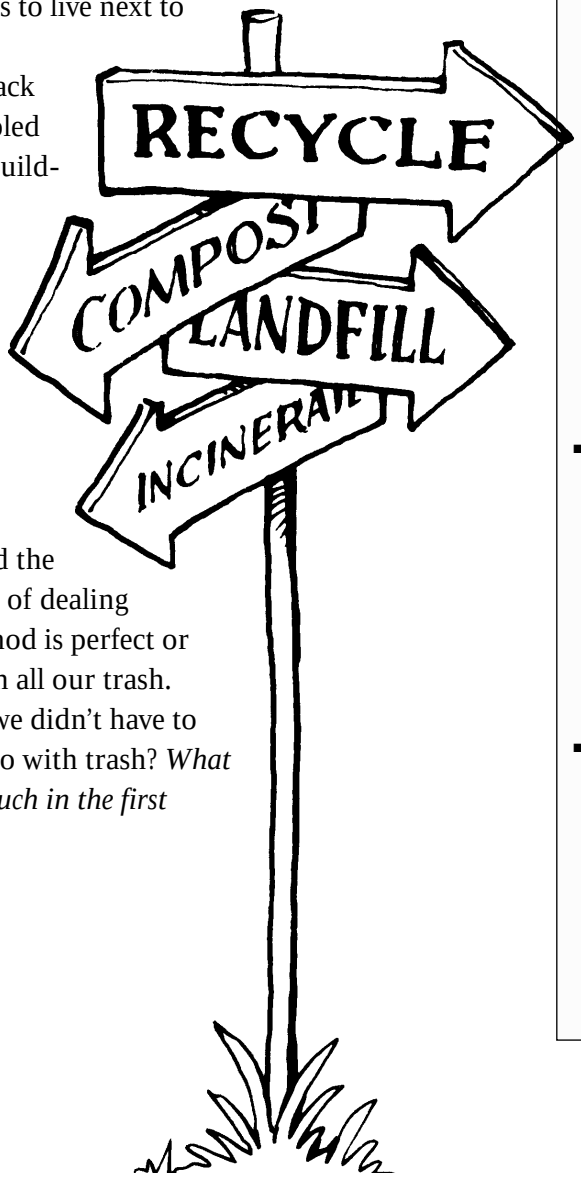
LANDFILLS

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

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

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

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



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

Strange But True Facts About Waste

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

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

Where Does the Trash Go?

WASTE DISPOSAL CHART

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

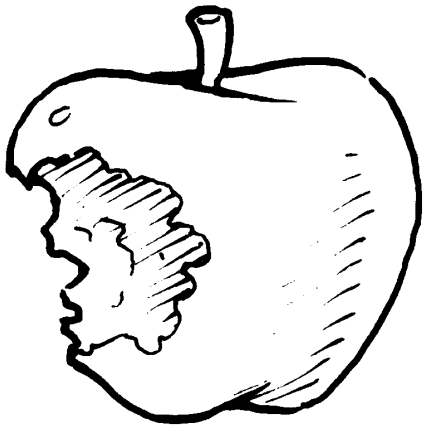
*** C = Composting**
R = Recycling
L = Landfilling
I = Incineration

Teacher's Notes

FOR WASTE DISPOSAL CHART

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

1. With the exception of home composting, all waste disposal methods (recycling, community composting, landfilling and incineration) use energy. Recycling is a process that requires transportation, sorting and manufacturing. Large-scale composting requires transportation and mechanical "turning" of materials. Incineration requires energy to transport material and then begin the burning process. Landfilling requires energy to transport materials to the site, and then to keep the site properly filled, drained, etc.
2. Landfilling is the only method that does not directly create useful by-products. Recycling creates new products, as does composting. Via burning, incineration can create energy by producing steam and electricity. (Indirectly, the methane gas in landfills can also be captured and turned into energy.)
3. All methods create some pollution. Composting gives off methane gas. Transporting materials burns fuel, creating air pollutants. Recycling processes also pollute, as do all manufacturing processes. Incineration creates some pollution as well, along with small quantities of hazardous waste, which must be properly handled, stored and/or landfilled.



4. Note that while batteries are listed as recyclable, recycling is not really economical. (That's expected to change in five to ten years.) Meanwhile, putting batteries into landfills can allow toxic acids and heavy metals to leach into soil and ground water.
5. Rubber tubing or tires can be ground up and used as filler in asphalt.
6. Wood scraps can be recycled into pressedboard or ground up for use in fireplace logs.
7. Fabric scraps are of limited recycling value. They can be reused, however, as rags or replacements for paper towels.
8. Foam cups can be recycled, although facilities for this are limited.

Answer Key: Where Does the Trash Go?

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Notebook paper	C, R, L, I	C, R, L, I	C, I	R, L, I
Fruit or veg. peel	C, L	C, L	C	L
Leaf	C, L	C, L	C	L
Plastic bottle	R, L, I	R, L, I	R, I	R, L, I
Glass jar	R, L	R, L	R	R, L
Wood scrap	C, R, L, I	C, R, L, I	C, R, I	R, L, I
Rubber tubing	R, L, I	R, L, I	R, I	R, L, I
Fabric scrap	L, I	L, I	I	L, I
Empty steel can	R, L	R, L	R	R, L
Aluminum foil	R, L	R, L	R	R, L
Foam cup	R, L, I	R, L, I	R, I	R, L, I
Battery	R, L**	R, L	R	R, L

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

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