Reuse or Recycle Hierarchy

Grades: 4-5
State Standards: Grade 4, Science; Physical Science, 1.g Students know electrical energy can be converted to heat, light, and motion. Grade 5, Science; Physical Science, 1.a Students know that during chemical reactions the atoms in the reactants rearrange to form products with different properties (extension).
Preparation Time: 25 minutes
Activity Time: 50 minutes
Key Words: Electricity, Energy, Manufacture, Recycle, Refine, Reuse

OBJECTIVE

Students will:
1. Compare the amount of energy and natural resources saved by reusing a plastic bottle before it is recycled.
2. Discuss different energy sources and inputs required to manufacture and transport a plastic product.
3. List three benefits of reusing something before it is disposed of.

MATERIALS

Students: “Energy of Making Plastic” worksheet
Teacher: “Making Plastic” overhead, “Energy of Making Plastic” worksheet overhead, "Energy of Making Plastic" worksheet answers, Plastic soda or water bottle

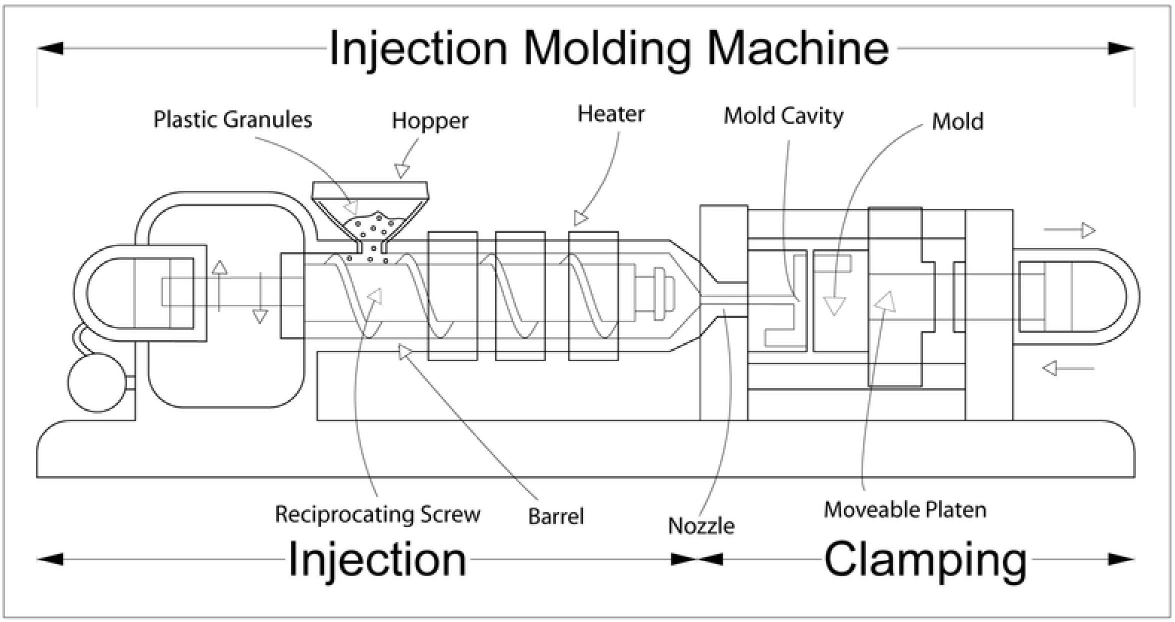
BACKGROUND

Reuse and recycling are quite different, but are often considered the same practice. Recycling involves the process of taking a product, deconstructing it and using the materials in remanufacturing a new product. A product that gets recycled may not always get remanufactured into the same product again. Recycling products conserves the resources and energy used during the early parts of the manufacturing process; however, the process of remanufacturing recycled products still requires energy and resources. Reuse involves the process of taking a product or material in its current form and using it for the same or different purpose without changing its original form. The practice of reuse reduces solid waste, conserves even more nonrenewable resources, and reduces emissions such as carbon dioxide released during the manufacturing process. Even though reusing and recycling saves money and landfill space, creates local jobs and keeps resources in our local economy, reusing items proves to be more efficient.

<u>Electric Injection Molding</u>
Approximately 346,500 tonnes of plastics packaging waste were recycled in 2004 (DEFRA) The typical method of producing packaging is through electric injection molding machines. Electric injection molding is widely used for manufacturing a variety of plastics, from wire spools, packaging, bottle caps, automotive dashboards, pocket combs, and most other plastic products available today. It is ideal for producing high volumes of the same object.

The process:

- granular plastic is fed by gravity from a hopper into a heated barrel.
- the melted plastic is forced through a nozzle that rests against the mold, allowing it to enter the mold cavity
- The mold remains cold so the plastic solidifies almost as soon as the mold is filled



<u>Discussion: Reuse, Recycle and Remanufacturing</u>

It can be easy to confuse remanufacturing with recycling. Remanufacturing products or purchasing remanufactured products is considered to be a waste prevention activity, not recycling. Why is that? Remanufacturing is considered to be another form of *reuse*, a key waste prevention strategy. Essentially, remanufacturing restores durable products to serve their original function by replacing worn or damaged parts. Recycling, on the other hand, converts the collected product or material back into a raw material to be used in the manufacture of a completely new product. Remanufacturing results in less waste and eliminates the need to purchase or manufacture a new product. Because fewer raw materials are used, remanufacturing conserves energy and natural resources. Remanufacturing automotive parts, for example, conserves an estimated 60 percent of the energy used in making the original product. It also reduces air pollution by keeping metals out of the resmelting process. Studies conducted by the Fraunhofer Institute in Stuttgart, Germany, state that the energy saved worldwide in a year by the remanufacturing industry is equivalent to the energy contained in 10,700,000 barrels of crude oil. In addition, the raw materials savings equals 155,000 railroad cars filled to capacity. Due to the numerous lives it gives a product, remanufacturing also conserves natural resources. According to industry experts, for each pound of new material used in remanufacturing, 5 to 9 pounds of original materials are conserved. And that’s not all. Purchasing a remanufactured product can cost as much as 50 percent less than a new

product, which can add up to real savings. Keeping durable goods out of the waste stream also helps companies save money in avoided disposal costs.
(See http://www.epa.gov/waste/partnerships/wastewise/pubs/wwupda6.pdf)

Vocabulary:
Electricity: the electric current used or regarded as a source of power.
Energy: the capacity for doing work. Forms of energy include thermal, mechanical, electrical, and chemical. Energy may be transformed from one form into another.
Thermoplastic is a polymer that turns to a liquid when heated and freezes to a very glassy state when cooled sufficiently.
Manufacture: to make or process a raw material into a finished product, usually by a large-scale industrial operation.
Recycle: the process of producing new products from used material or the process of remanufacturing used materials into new products. Some used materials can be made into new items of the same thing. Others are made into entirely new items.
Refine: the process of purification or transformation of a substance. Refining is often used with natural resources that are almost in a usable form but that are more useful in pure form. For example, most types of petroleum will burn straight from the ground, but will burn poorly and quickly clog an engine with residues and byproducts.
Reuse: extending the life of an item by reusing it again as it is or creating a new use for it in the same form.

PROCEDURE

1. Explain that many of the things we use everyday are made, or "manufactured," in factories using some kind of raw material. Ask the students what paper is manufactured from. Explain that the process of making things for people to use has several steps: Draw a T-chart on the board as shown below and fill in first column only:

Manufacturing Steps	Manufacturing a Plastic bottle
Collecting raw materials	Drilling for oil
Cleaning materials ("refining")	Cleaning or refining the oil
Making the item	Making oil into plastic, shaping plastic into bottles, filling bottles with a drink
Packing	Pack bottles into boxes
Transporting to store	Transport to stores in trucks, trains, boats
Selling to customer	Store sells bottles
Use of product	Purchase bottle and use it

2. Explain another example of something that is manufactured such as a plastic bottle. Ask the students what the bottle is made from. Show a clear plastic bottle. Explain that plastic bottles are made from black, liquid oil that is pumped out of the ground. The atoms in the oil are rearranged and combined with other things during manufacture to make plastic: solid but a little flexible, fairly clear. Show the overhead: "Making Plastic." Complete the T-chart by writing down the steps to manufacturing a plastic bottle.

3. Ask students what they might do with a plastic bottle when they're finished drinking the contents? Record their answers on the board. Ask the students if they can think of ways to use the bottle again. Explain that there is an important step in the 4Rs hierarchy that comes before recycling: Reuse. When we reuse something, it is used for a new purpose. When we're finally done with it, we can still recycle the bottle. When the bottle gets recycled, it will go back to the manufacturing part of our process to get made into a new thing, instead of having to pump more oil and make more plastic. Refer to T-chart and draw a line labeled recycling connecting back into manufacturing from bottom.

4. Ask students to name items they often recycle but do not reuse. Write the names of these items on the board. Why do people use some things only once before recycling? Examine some of the reasons that people do not reuse items before recycling; i.e., convenience, durability, accessibility to purchasing a new item, cost, it can't be refilled, it's dirty, etc.

5. Ask students to define reuse (to use again) and write their definition on the board. Then ask them to define recycle (making something old into something new, the process of remanufacturing used materials into new products).

6. Tell the students that they will learn why reuse is so important and why it comes before recycling in the 4Rs hierarchy by looking at how much energy is saved by reusing a plastic bottle before it is recycled.

Activity

1. Explain that if a bottle is reused to carry water or something else instead of buying a new one, we save natural resources and energy.

2. Ask the student to consider how much energy might be saved by reusing a bottle. Define energy: the capacity for doing work. Explain that energy is stored in food, batteries, and different fuels like gas. Energy is carried by electricity, waves of water or sound, and moving objects. Have the students discuss different ways that they use energy and identify where it comes from. Make a T-chart on the board with the titles below and ask students to complete the T-chart.

Where we use energy	Where we get it
In our bodies	Food
Light our rooms	Electricity
To get around, cars and trucks	Gas, electricity
Cook food	Gas, electricity
Make things in factories	Gas, oil, electricity

3. Ask the students to describe what and where energy might be used to make a plastic bottle? Show the overhead "Energy of Making Plastic." Discuss and circle the different energy sources and inputs required to manufacture and transport a plastic product.

4. Have the students describe the hierarchy of energy used: If a plastic bottle is reused? If you buy a new product made from recycled plastic?

Is the energy required to reuse a product different from the type of energy used to remanufacture a new product.

Discuss the differences.

- If the item is reused in line with its original intended use, new materials and new sunk energy costs can be avoided. This is the highest form of reuse. (Washing the bottle, uses time and water)
- Reuse of recycled energy-intensive items takes the best advantage of the energy invested in these items. Reuse of separate components (that haven't been altered) is next best. (disassembling costs, gas, electricity)
- Remanufacturing and extending the life of an item, sunk energy costs can be minimized or retrieved and will stretch our finite resources. Direct reuse of an item is the best advantage of the energy invested. (a tire can be retreaded up to 10 times. Recycled rubber from retreads can be shredded to make rubber mulch. Energy to buffing off of the old tread, coat with another compound like rubber to allow the new tread to adhere to the used tire casing).

5. Tell the students that they will work with a partner to compare the amount of energy required to make a new plastic bottle, reuse a bottle and recycle a bottle.

6. Assign the students to work in pairs. Hand out a worksheet "Energy of Making Plastic" to each pair of students. Model how to complete the worksheet.

Discuss

1. Come back together as a class and discuss their findings with a series of questions, for example:

• How many energy units are required to reuse a plastic bottle versus buying a new bottle made from recycled plastic?
• If you reuse a plastic bottle before recycling it, how many energy units are you saving? (A bottle's worth of energy for each time you reuse it.)
• Which action conserves more natural resources reusing or recycling? (reuse)
• Did anyone think of some other things that are saved when you reuse, besides energy?

(Go back to the overhead "Making Plastic" to discuss other resource inputs and pollution outputs. An interesting fact to share is that local environmental scientists have figured out that it takes more water to make the bottle than a plastic water bottle actually contains for you to drink. The process of moving the materials and bottles around and manufacturing the bottle produces both air and water pollution. Time, money, and landfill space are other savings associated with reuse.)

2. Ask students to describe other things that people throw away that could be reused?

3. Explain when an item such as a plastic bottle is reused, all of the resources and energy required to make plastic and manufacture and transport a new bottle are conserved. Even if the new bottle was recycled, energy and resources are still required to transform the recycled plastic into a new product—so reuse before you recycle!

4. Have students write a paragraph describing why reuse is placed before recycling in the 4Rs hierarchy, citing at least three benefits of reusing something before it is recycled or thrown away. Have them describe one specific example of an item they use from home that can be reused before it is recycled.

Extension

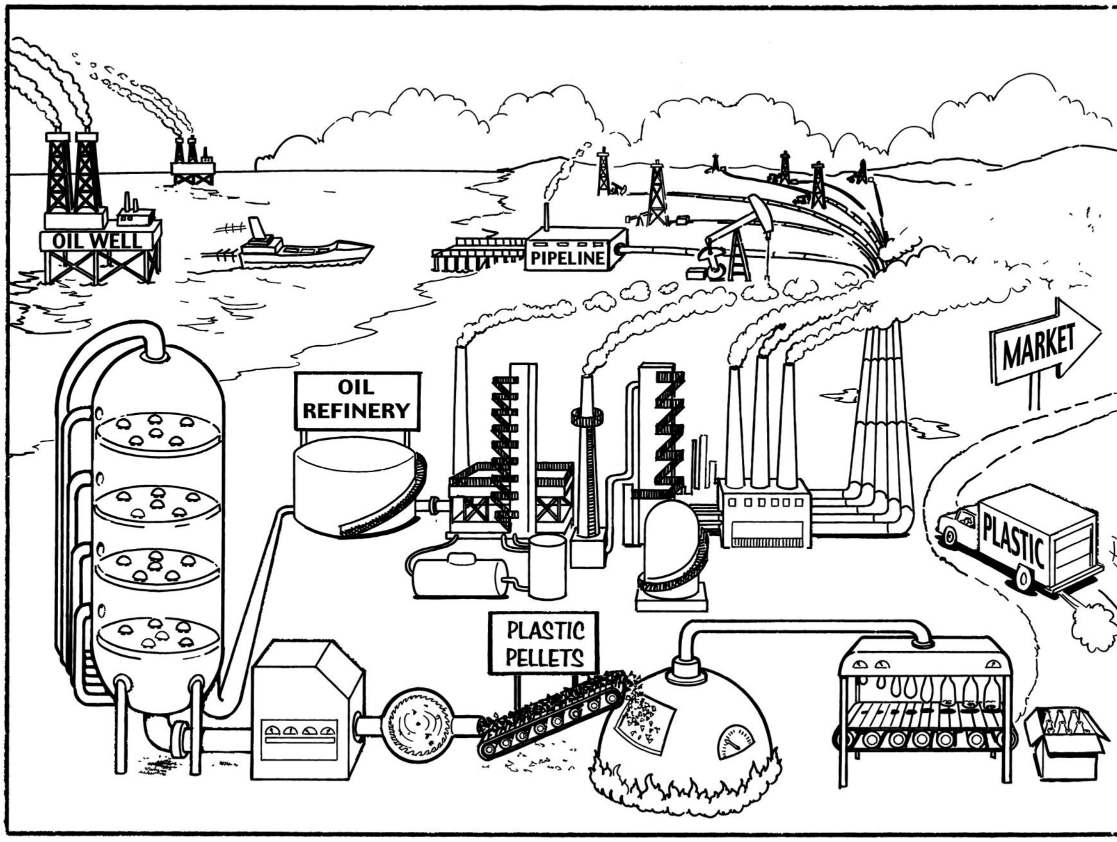
Have students contact their local utility company to find out how the electricity they use is generated (gas-fired power plants, wind power, hydroelectric, coal-fired or biomass power plants, geothermal power) and research the availability and impacts of these energy sources. Research different types of energy used during the manufacturing process of a common product. Compare the elements found in oil and the elements found in plastic and look at the different molecular structures that make these hydrocarbon molecules have such different properties. See the Reciprocal Net website for pictures of fuels and polymer compounds that can be manipulated on the computer screen to see the structure.

http://www.reciprocalnet.org/edumodules/commonmolecules/material/index.html

ANALYSIS

By reusing and recycling we minimize landfill impacts. The process of moving the materials and bottles around and manufacturing the bottles produces both air and water pollution. Time, money, and landfill space are other savings associated with reuse and recycling.

Making Plastic



Wells pump crude oil on land and deep beneath the ocean. Oil is shipped and transported to oil refineries. Oil is refined and turned into plastic pellets. Plastic pellets are melted and formed into plastic products. Plastic products are packaged and shipped or transported to stores that sell the products.

Energy of Making Plastic

1. Describe at least three ways that energy is used to make a plastic bottle.

A.

B.

C.

2. Which practice conserves more natural resources and saves energy: **reuse** or **recycle**? Why?

3. Describe three benefits of reusing a product before recycling it.

A.

B.

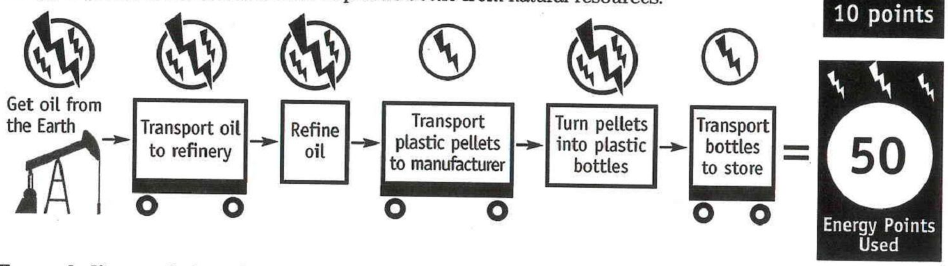
C.

Teacher

Energy of Making Plastic

Directions: Look at the diagrams below showing the difference between the manufacturing, reuse and recycling of a plastic bottle.

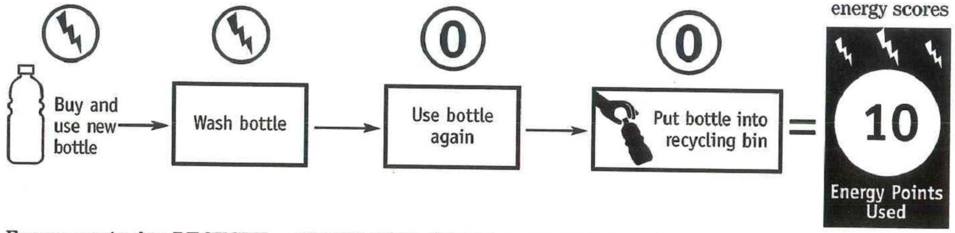
Energy required to **MANUFACTURE** a plastic bottle from natural resources:



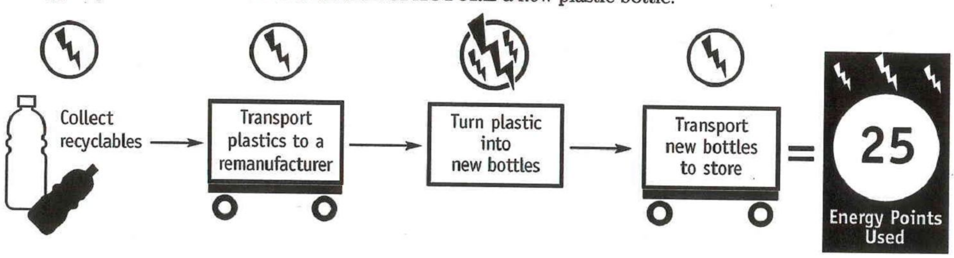
For each diagram below, draw an energy symbol in the circle to show where energy is used during the reuse or recycling process of a plastic bottle.

Energy required to **REUSE** a plastic bottle:

Compare your energy scores



Energy required to **RECYCLE** and **REMANUFACTURE** a new plastic bottle:

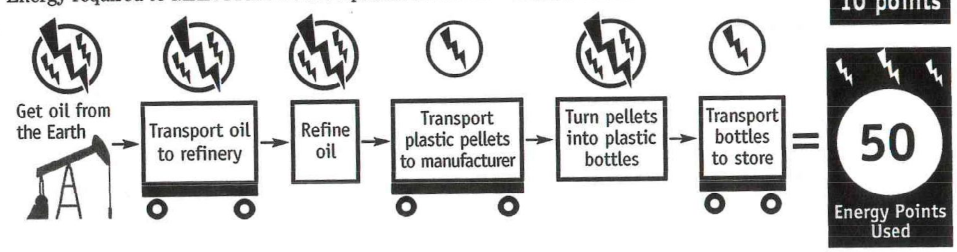


Student

Energy of Making Plastic

Directions: Look at the diagrams below showing the difference between the manufacturing, reuse and recycling of a plastic bottle.

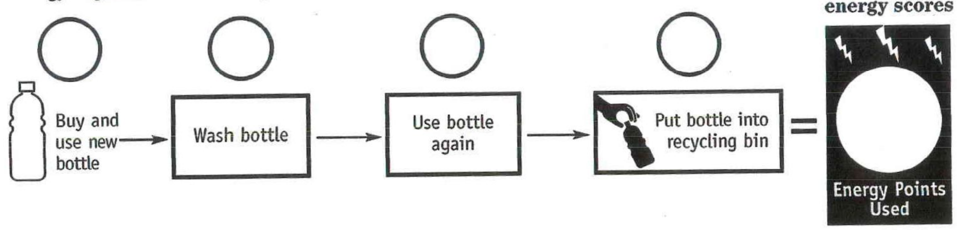
Energy required to **MANUFACTURE** a plastic bottle from natural resources:



For each diagram below, draw an energy symbol in the circle to show where energy is used during the reuse or recycling process of a plastic bottle.

Energy required to **REUSE** a plastic bottle:

Compare your energy scores



Energy required to **RECYCLE** and **REMANUFACTURE** a new plastic bottle: