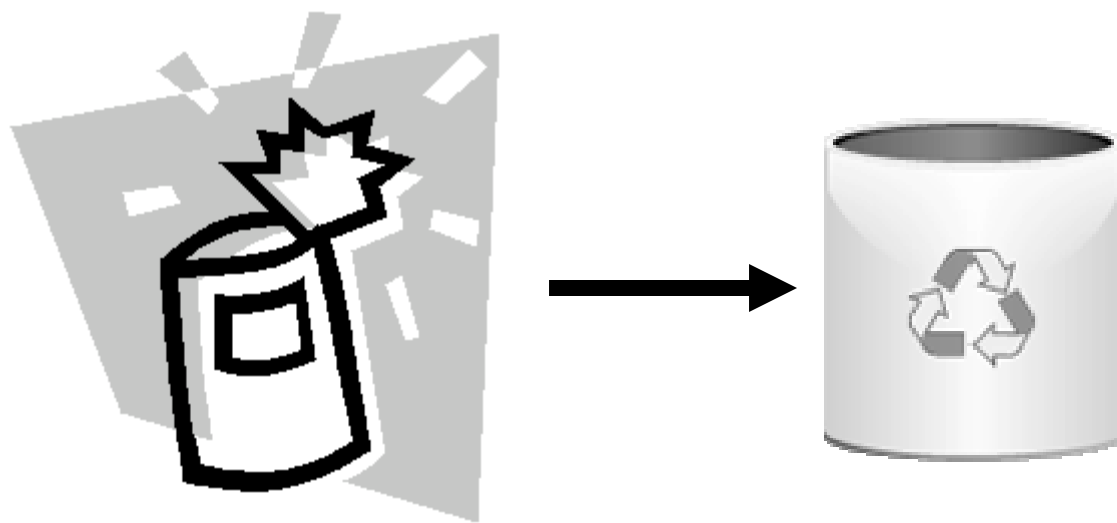




Lesson 4

Our Trash Never Goes Away!

(But recycling can change a linear life into a
"Designed by Nature" product life cycle.)



Notice: The materials in this document were developed by faculty from Eastern Michigan University and staff of Creative Change Educational Solutions and may not be used or reproduced without citing *Designed by Nature*.



Inputs and Outputs of the Burning Nut and Dissolving Sugar Cube

Burning Nut:

Name _____ Date: _____

Inputs:

ENVIRONMENT

Outputs:

- _____ (_____, _____)
- match (CPE, heat)
- work (_____)

Entropy happens during
transformations:

_____ (nut) → cold(er) (water, air)

- heat, smoke,

- warm water,
- warm _____

NOTHING EXITS THE ENVIRONMENT... THERE IS NO "AWAY"!

Dissolving Sugar Cube:

Inputs:

ENVIRONMENT

Outputs:

- warm water
- _____ (to air)
- _____ (mass)
- _____ (stirring)

Entropy happens during
transformations:
dissolution, diffusion

- _____ (to air)
- sugar water

NOTHING EXITS THE ENVIRONMENT... THERE IS NO "AWAY"!



THE LAWS OF THERMODYNAMICS

(Thermodynamics is the study of heat and its relationship to mechanical work.)

1. **The Law of Conservation of Energy:** Energy is never created or destroyed, but is transformed from one type of energy to another. All mechanical energy is eventually transformed into heat energy.

For example:

- The nut has chemical potential energy (CPE) stored as fat and measured in Calories.
- The match has chemical potential energy (CPE) that is released through doing work (exerting a force through a distance).
- As the nut burns, its stored energy is converted into heat and light and smoke (which has mass).
- The heat goes into heating up the water.
- Energy will always naturally flow from hotter objects to colder objects.
- The heat (energy) lost by the nut is the heat (energy) gained by the water and air.

2. **The Law of Entropy:** With each step of transformation, the energy is less useful (or able) to do work. The heat becomes more and more diffused (scattered).

For example:

- The burned nut no longer has any caloric (nutritional) value.
- The heat and light produced by the nut are lost to us. The water may be a bit warmer, but it will continue to cool off into the colder room.
- The transformation of energy from concentrated forms (in the nut and match) to less concentrated forms (the burning nut and match and warmer water - which all distribute heat into the room) are examples of entropy. The energy is present in the room, but cannot be gathered and put back in the nut to nourish you nor can it heat the water again.



Recycling Facts

- About one-third of an average dump is made up of packaging material!
- 75% of our trash can be recycled.
- Every year, each American throws out about 1,200 pounds of organic garbage that can be composted.
- New Jersey has the highest recycling rate of all the states—56%!
- The U.S. is the #1 trash-producing country in the world at 1,609 pounds per person per year. This means that 5% of the world's people generate 40% of the world's waste.
- Out of every \$10 spent buying things, \$1 (10%) goes for packaging that is thrown away. Packaging represents about 65% of household trash.
- Americans generate and throw away 9 times as much waste as does a person in Africa or Central America, but we also generate two to three times the amount of waste as people living in industrial countries with a comparable or better standard of living as us.
- The US population discards each year 16,000,000,000 diapers, 1,600,000,000 pens, 2,000,000,000 razor blades, 220,000,000 car tires.
- Between 5 and 15% of what we throw away contains hazardous substances.

This list of facts is just a few from this website.

Washtenaw County's Department of Planning and Environment, 2007, *Trash, Metals, Plastic, Paper, Glass*, http://www.ewashtenaw.org/government/departments/planning_environment/dpw/recyclefacts.html, accessed on May 23, 2007



LIFE CYCLE OF AN ALUMINUM CAN

The can that contains your favorite beverage is made of aluminum, a metal that makes up 7.3% of the earth's crust. After iron, aluminum is the second-most widely used metal in the world. Aluminum's life cycle from the earth's crust to a beverage container follows these steps:

- **Mining:** Aluminum is contained in bauxite ore, a reddish clay-like material that is mined from the earth. Bauxite mines are located in many regions worldwide, including the Amazon, and sub-Saharan Africa. Mining requires large machinery and human labor, and involves removing large quantities of forest and/or soil to reach the ore. If precautions are not taken, pollution and sediment can wash into nearby waterways.
- **Processing, Part 1:** To free the aluminum from the bauxite ore, the ore must be stripped or reduced of its oxygen. This process, called reduction, is done at a reduction plant, or smelter. The ore is put into large pots at the reduction plant and dissolved into a molten (or liquid) state. Then a powerful electric current is run through the liquid to separate the aluminum from the oxygen. This reduction process requires a tremendous amount of electrical energy. Making a pound of aluminum (enough for 32 cans) takes 7.5 kilowatt-hours of electricity.
- **Processing, Part 2:** Once the aluminum is separated, large machines press it into giant rolls. The cans are formed from this. These steps require electricity, too.
- **Consumption:** After the can is filled with a beverage, it is taken to a store where you buy it. Transporting the beverages requires fuel.
- **Disposal:** An aluminum can that is thrown away will still be a can 500 years from now! Americans throw away enough aluminum every three months to rebuild our entire commercial air fleet!



Inputs:

- bauxite
- machines for mining
- energy for mining
- human labor
- fuel to generate electricity

ENVIRONMENT

Entropy happens during transformations:
Expending energy for mining
Removing oxygen from the ore
Processing the aluminum into a can

Outputs:

- emissions
- pollution
- heat
- aluminum cans

NOTHING EXITS THE ENVIRONMENT... THERE IS NO "AWAY"!



Recycling: When outputs become inputs

Producing an aluminum can from bauxite ore takes a tremendous amount of energy and other inputs. But there is a way to make cans using 95% less energy. How? The answer is **recycling**.

In recycling, the outputs—used cans—become inputs for new ones. In other words, something that would be trash (a used can) turns into a valuable input for producing new products. Using recycled cans avoids mining, saving all the inputs and energy needed to process 'virgin' aluminum.

Consider the life cycle of a recycled can:

- **Gathering inputs (cans):** Making a recycled can does not require mining and reducing bauxite ore to get aluminum. Instead, the aluminum comes from the cans you recycle. Your cans go to recycling centers, and scrap metal companies purchase the cans. The aluminum industry operates a coast-to-coast network of 10,000 buy-back locations nationwide and cooperates with more than 7,945 cities and counties with municipal or curbside recycling programs.
- **Processing:** At a processing facility, machines condense the recycled cans into highly dense, 30-pound "bricks" or 1,200-pound bales. The cans are then shipped to aluminum companies, where the condensed cans are shredded and crushed into potato-chip sized pieces. Then the pieces of aluminum are loaded into melting furnaces where the recycled metal is blended with some new, virgin aluminum.

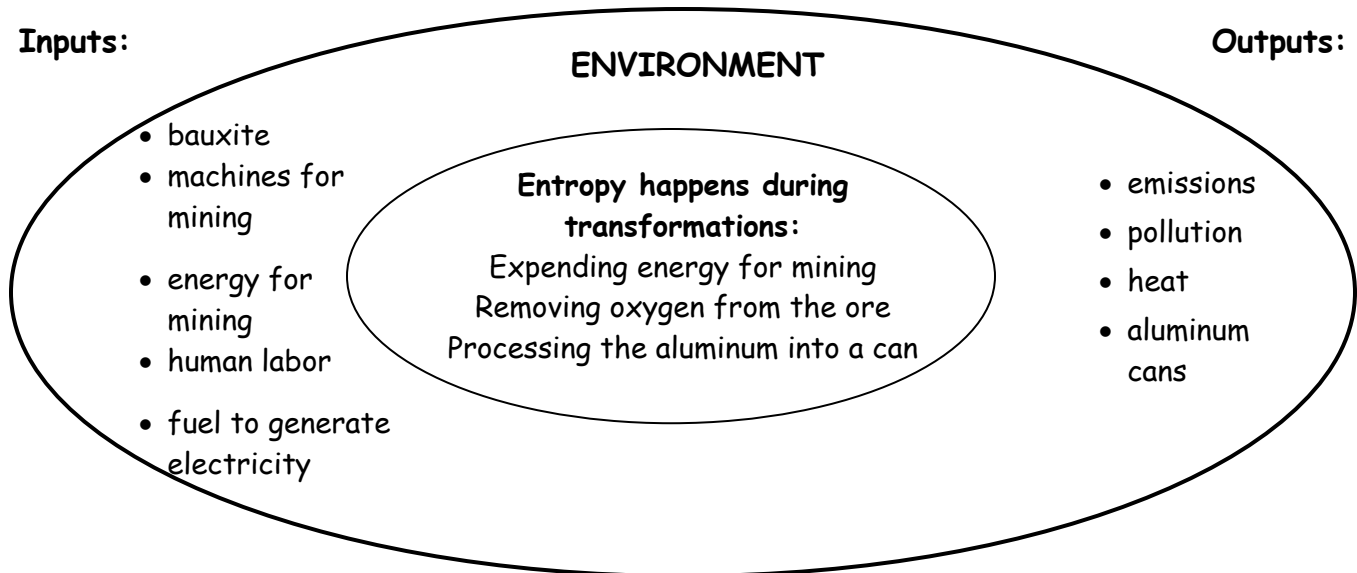


- The molten aluminum is then poured into 25-foot long ingots that weigh over 30,000 pounds and are over 20 inches thick. The ingots are fed into rolling mills that reduce the thickness of the metal to about 10/1,000 of an inch thick - the same thickness as a human hair. The cans are then sent to beverage companies for filling.
- **Consumption:** The new cans, filled with your favorite beverage, are on store shelves in as little as 60 days, only to go through the entire recycling process again! There is no limit to the amount of times an aluminum can can be recycled. Some 119,482 cans are recycled every minute nationwide.



RECYCLING AND ENERGY SAVINGS

Inputs and outputs of making an aluminum can



NOTHING EXITS THE ENVIRONMENT... THERE IS NO "AWAY"!

Energy savings from recycling aluminum

- Recycling is when outputs (wastes) become inputs (resources to make new products).
- Making a can from recycled cans saves the energy and resources needed to mine and process virgin aluminum:
 - It requires only 5% as much energy when a can is made of recycled aluminum as compared to virgin ore!
 - Recycling one aluminum can saves enough energy to run a TV set for three hours, or to light one 100 watt bulb for 20 hours. Recycling two aluminum cans saves the energy equivalent of a cup of gasoline.

Recycling other materials also saves money and energy and creates jobs

- Recycling all of your home's waste newsprint, cardboard, glass, and metal can reduce carbon dioxide emissions by 850 pounds a year.
- On average, it costs \$30 per ton to recycle trash, \$50 to send it to the landfill, and \$65 to \$75 to incinerate it.
- Incinerating 10,000 tons of waste creates 1 job, land filling the same amount creates 6 jobs, recycling the same 10,000 tons creates 36 jobs.
- Every time a ton of steel is recycled, it means 2500 pounds of iron ore, 1000 pounds of coal, and 40 pounds of limestone will not have to be mined from the earth. Annually, enough energy is saved by recycling steel to supply Los Angeles with electricity for almost 10 years.

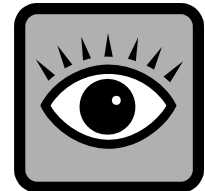


Recycling Writing Activity - Graphic Organizer

Name _____ Date: _____

Write either a 30-second radio or TV public service announcement to encourage recycling or a letter to your parents, principal, state governor, or President about the importance of recycling. Use the following "writing prompts" to organize your thoughts, then write the complete paragraph on your Recycling Writing Activity sheet. Be creative. Have fun!

Attention-Getting Opener:



Statement #1 about recycling:



1

Statement #2 about recycling:



2

Statement #3 about recycling:



3

Concluding statement:





Recycling Writing Activity

Name _____ Date: _____

Directions:

Using your notes from your graphic organizer, write your TV announcement or letter below:

A large rectangular area containing 20 horizontal lines for writing.