Unit 1 (Materials):
The Materials Cycle

Concept
There is a cycle of production for the things we use every day. Energy is the cost of keeping the cycle going, and we can save energy by closing some of the loops.

Content objective
Students understand the production of some materials and become familiar with the Materials Cycle.

Language objectives
Discuss the main features of green re-cycling.
Interpret and discuss short readings on green design principles using comparative languge, e.g., *adjectives and conjunctions.*
Explain how raw materials are processed using logical connectors: *sequencing words- because, then, subsequently, consequently.*

Standards

- **NGSS**:
  - **3-LS4-4.** Evaluate a solution to a problem caused when the environment changes and how the types of plants and animals that live there change.
  - **3-ESS2-1.** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
- **TEKS:**
  - **1B** Students will make informed choices in the use and conservation of natural resources and reusing and recycling of materials.
  - **6A** Students will differentiate among forms of energy, including mechanical, sound, electrical, light, and
  - heat/thermal.
- **ELPS:**
  - **1C** Students will use strategic learning techniques, such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary. [Metacognitive Strategies]
  - **3D** Students will speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency. [Application for Acquisition]

- **4G** Students will demonstrate comprehension of increasingly complex English by participating in shared reading, retelling or summarizing material, responding to questions, and taking notes commensurate with content area and grade-level needs.

Materials

- Chalk or 8 playground markers, such as traffic cones or softball bases
- Lesson handouts **4.1.1- 4.1.8**
- Realia for students to use in walking the Materials Cycle

Literature Connections

The Three Little Pigs: An Architectural Tale by Steven Guarnaccia

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language Requirements
1. Ask student pairs to discuss for a few minutes what they know or have heard about life cycles. They may know about the life cycles of living things, seasons, and other examples. Discuss with them how anything that occurs over and over again in a pattern of returning to the beginning is a cycle. 2. Hold up or point to a classroom object that has been made by people, such as the overhead projector. Ask students if objects such as this might begin and end in a cycle of some sort. 3. Continue discussing the object and how it might have been made, while collecting the students' ideas about the source of manufactured items. 4. Help the students learn about the production cycle of a chosen raw material using visuals. You might trace the production of a popular toy to capture their interest. 5. Organize students into groups and ask them to select a life cycle to discuss and to illustrate, using handout **4.1.1**. 6. Have each group write about its material using the handout provided and then share the results with the rest of the class.	Students reflect, discuss, and share ideas based on what they know of life cycles Students use a graphic organizer to focus on one life cycle to analyze, to discuss, and to write about in groups before sharing their knowledge with the rest of the class	Cycle Production cycle Raw material

Day 2: Explore/Explain

Teacher Says/Does	Student Says/Does	Language Requirements
1. In whole group, show students the materials cycle with a green loop (**4.1.2**). Ask one or two students to describe what they see on the handout. 2. Organize an election among students to select one life cycle that will be analyzed using the materials cycle in the lesson handouts. 3. Trace the story of the selected item on the materials cycle. Ask the children what might happen to the sample object when it is no longer useful. Collect a few responses. Prompt students to talk about their selected material using sentence starters from handout **4.1.3**. 4. Using handout **4.1.4** as a guide, select students to read each of the eight sentences, and ask questions that will lead them to select the right choice of word in each case. 5. Organize students into five groups and distribute each a paragraph from handout **4.1.5** for students to read and discuss. Have each group share the main idea, one important detail, and one way in which this is important in their daily lives. 6. Have each individual student write up at least two sentences that reflect on green design based on the ideas discussed (see handout).	Students discuss a diagram illustrating the materials cycle and use sentence starters to talk about the life cycle of the material selected Students read and discuss sentences about green design Student groups read and analyze the paragraphs, identifying main ideas and sharing one aspect that is relevant in their lives Students read and analyze sentences related to green design Students individually construct sentences integrating ideas discussed	Production cycle Landfill Raw material Process material Dispose Recycle Fix, refill, reuse Employ sentence starters in handouts for students to use as part of oral discussions and for writing their reflections

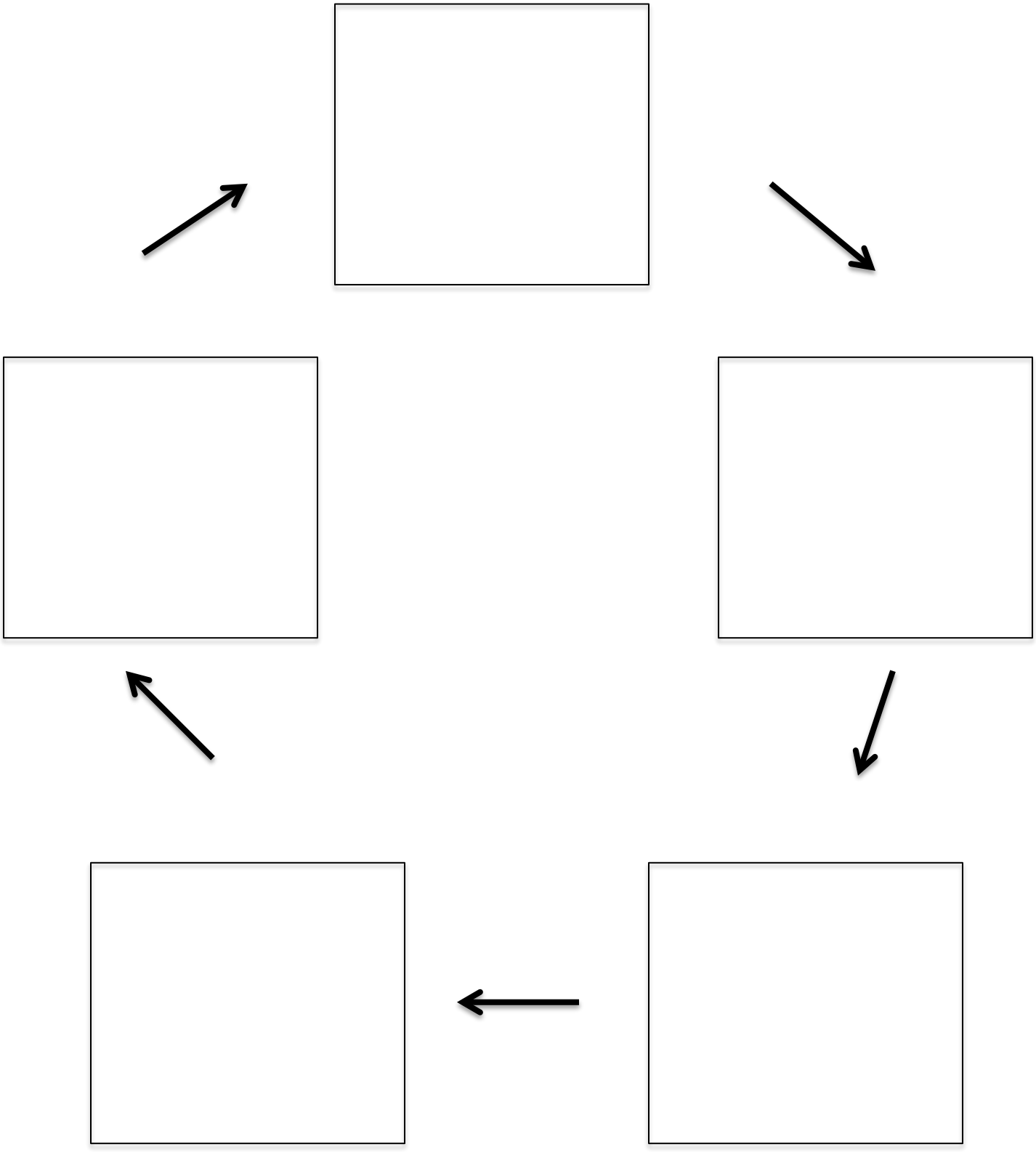
Day 3: Explore/Explain

Teacher Says/Does	Student Says/Does	Language Requirements
1. Remind students of materials cycle completed the previous day (**4.1.1**) and discuss key elements/processes. 2. Organize students in teams so that each team will play the part of a raw material and a product, using a slip cut from the Raw Materials Role Play handout (**4.1.6**). 3. Student groups discuss the cycle of each of their raw materials using the materials cycle. 4. When students get to the "USE" part of the cycle, they need to think about the material's end-of-life. Will they recycle? Will they fix? Will they reuse? How? Students should explain what they would do to prevent having to DISPOSE of their material. Whenever a team thinks of a new way to stay in the "green loop," everyone should cheer from the Earth. 5. Have one student from each team stand in the Earth section of the cycle. The rest of the students will watch the representative walk through the steps with the chosen raw material, while telling what the material is and how it is processed. 6. Questions to ask the students: o How is recycling helpful to the Earth? o Where do people make the biggest impact on the materials cycle? (Buying, creating demand for new things, or helping to recycle) 7. Organize students in pairs and have each choose another raw material and, using the materials cycle handout (**4.1.1**), analyze the effects of make each of the following three choices: dispose of the material in the Earth, such as a landfill or dump; recycle it into basic materials; or fix and reuse it. 8. Have the students use sentence starters to write about their materials and/or allow them to write freely about their material, as long as they refer to the materials cycle handout. 9. Have students present their reflections to the whole group.	Students use a handout to describe a materials cycle Students role play with different materials to examine each material's life cycle	Production cycle Landfill Raw material Process material Dispose Recycle Fix, refill, reuse

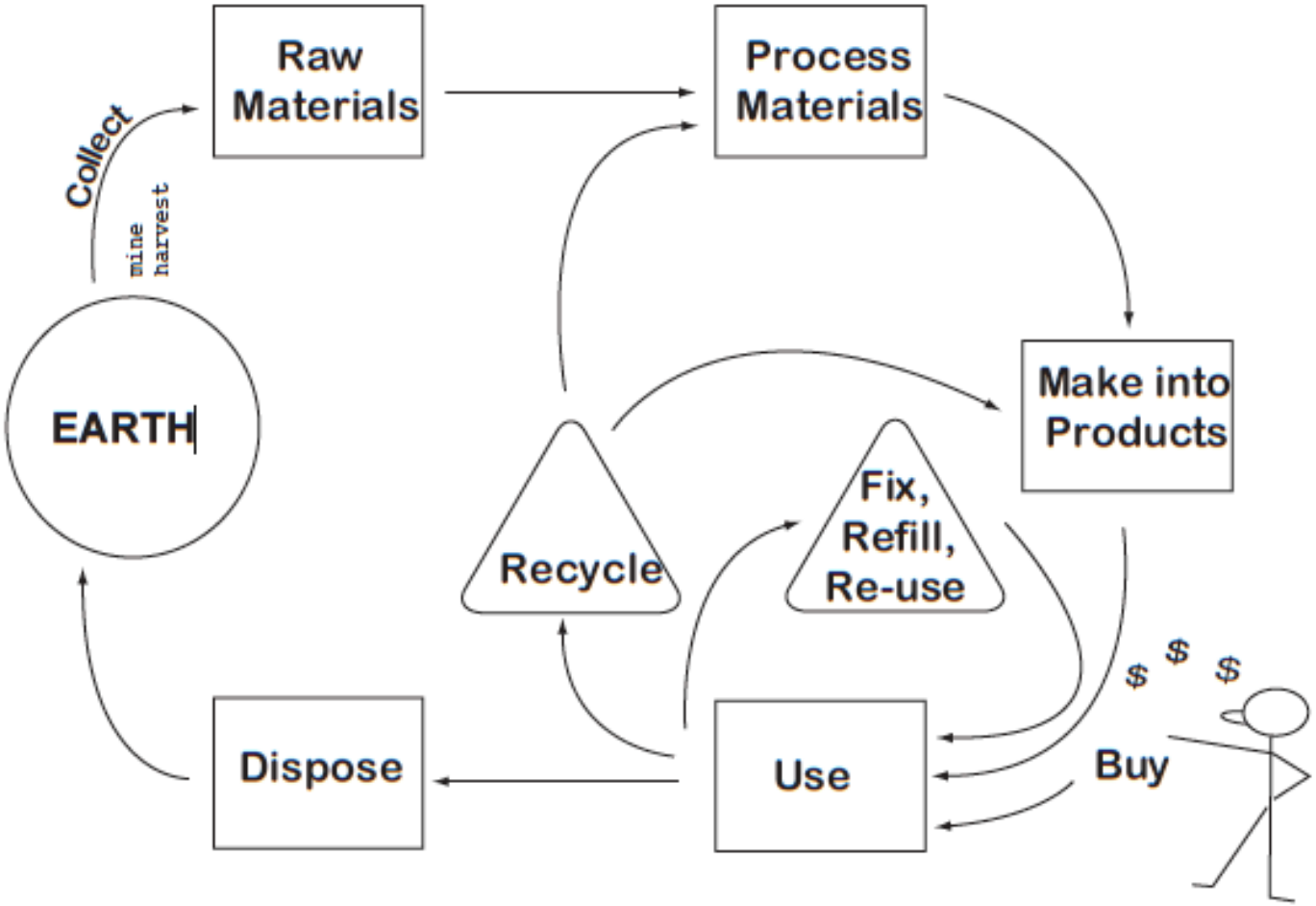
Day 4: Elaborate and Evaluate

Extensions into the Disciplines	Practical Extensions	Language Requirements
1. Have students review the graph on handout **4.1.7**, "Earth, We Have a Problem." 2. In whole group, discuss the graph, and collect students' ideas about what the graph tells us. 3. Organize students into pairs and, have each analyze one statement from the bottom half of the handout, and share their understanding with the class. 4. Discuss with the students what Earth's environmental problems are and the implications of these problems.	Students discuss a graph on garbage production and recycling	See handouts

Life Cycle



Total Materials Cycle with a Green Loop Resource



Sentence starters to write about the material chosen:

The raw material that we chose is _____.

We can buy it at _____.

It usually lasts _____.

It can be disposed by _____.

When we dispose of it, it becomes part of _____.

When we recycle it, it becomes part of _____.

It can/cannot be recycled because _____.

It can/cannot be fixed, refilled, and re-used because _____.

One difference between raw materials and processed materials is _____.

In the following sentences, select one of the two words in parenthesis that would apply to green design.

1. Green design involves using (less/more) virgin or raw material.
2. We generate waste that will have a (small/big) impact on the environment.
3. We want to (prevent/allow) toxic waste from manufacture, recycling, and disposal.
4. We design products so their packaging (can/cannot) be recycled.
5. We design machines so they can be (assembled/disassembled) easily.
6. We use (less/more) material and energy to do the same work as original designs.
7. We use (few/ many) raw materials in manufacture that reach the DISPOSAL stage of the Materials Cycle.
8. We want to (decrease/increase) the time that products stay in use.

Group 1: Raw Materials

The Earth's resources include organic and inorganic matter that we harvest for production. These *raw materials* include mineral ores containing metals, such as iron, aluminum, nickel, copper, tin, gold, silver, zinc, mercury, and lead. Non-metallic minerals include sand, gravel, limestone, salts, and sulfur. Organic raw materials include fossil fuels (natural gas, coal, and petroleum) and plant materials, such as wood.

Group 2: Energy is the Bottom Line

The farther we take a raw material in the Materials Cycle, the more energy we use in its processing. We can call this energy use "solar dollars," which includes all the energy consumed since the raw materials were created. These solar dollars will include the energy involved in the creation of a mineral, the energy we use to find and transport materials, *and* the energy we need to train, feed, and transport the people involved in the process. Along every stage of processing, we consume solar dollars. However, we don't incorporate these "solar dollars" (the true cost) in the cost of the finished product.

Group 3: What consumers can do

Consumers who want to conserve energy will *reduce* their purchase of non-recyclable packaging and products, *re-use* packaging and products, and *recycle* organic and inorganic materials so that as few items as possible enter the DISPOSE phase of the Total Materials Cycle. The "green loop" of the Materials Cycle is the area in which we learn how to do just that.

Group 4: How engineers practice green design

Engineers want to make it easier for materials to avoid disposal, so they practice "green design." One way of practicing green design is to use recycled materials. An example is Dupont recycling milk jugs into park benches and padded envelopes. IBM recycles the housing on their computers into roofing tiles for McDonald's restaurants. Another way of practicing green design is to create packaging that can be refilled and recycled. For example, Proctor and Gamble Company makes many of their products in sturdy containers and sells refills, reducing their packaging needs by 80%. A third way of practicing green design is to consider end-of-life issues so there are as few steps as possible in taking a product apart for recycling, as when a product can be disassembled in seconds.

Group 5: Saving costs with Green Design

Engineers can save energy in processing and disposal, and, therefore, lower costs. For example, by practicing green design in auto manufacture, Chrysler Jeep [<removed /] saves $2 million per year on its garbage bill and eliminated 70% of landfill-bound trash. Whirlpool Company, in Germany, reduced its number of packaging materials from 20 to 4, which decreased their disposal costs by 50%.

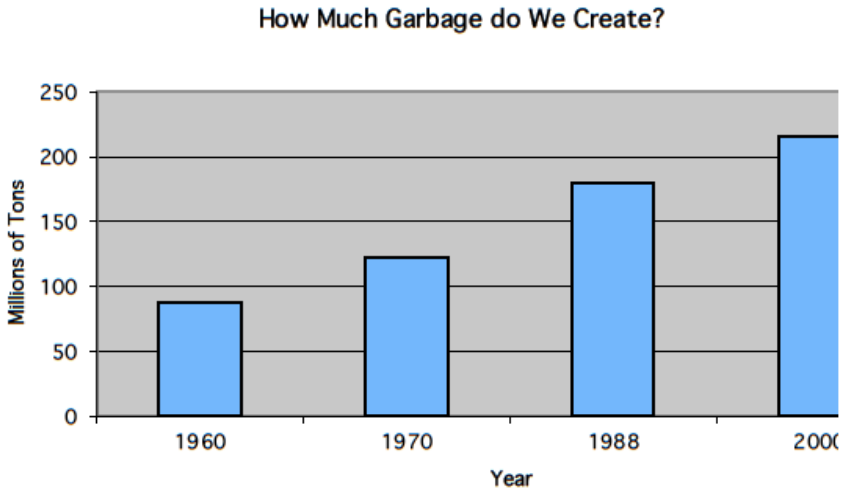
Source: Fowler, Crawford, Wood & Jones (2000). Beginning Lessons in Engineering Design Level D Lessons. Green Design Learning Experience Background Information (p. 12)

Raw Materials Role Play

1. You are wood that is cut and then processed into pulp and then made into school paper.	2. You are wood that is cut and then processed and cut and then made into lumber.
3. You are bauxite, aluminum ore, and you are mined and then processed and then made into aluminum and then made into a soft drink can.	4. You are bauxite, aluminum ore, and you are mined and then processed into aluminum and then made into a ladder.
5. You are iron that is mined and then processed with carbon into steel and made into a can to hold beans.	6. You are iron that is mined and then processed with carbon into steel that is made into car bodies.
7. You are copper that is mined and then processed and made into electrical wire.	8. You are copper that is mined and then processed and then made into a cooking saucepan.
9. You are copper that is mined and processed with zinc to make brass and then is made into door hinges.	10. You are copper that is mined and processed with zinc to make brass that is made into a musical horn like a trumpet.
11. You are the oil (petroleum) gas called ethylene that is collected and then processed into polyethylene and then processed into high-density polyethylene (HDPE) and then made into milk jugs. (# 2 plastic container code)	12. You are the oil (petroleum) gas called ethylene that is collected and then processed into polyethylene and then processed into low-density polyethylene (LDPE) and then made into plastic bags. (# 4 plastic container code)
13. You are the oil (petroleum) gas called ethylene that is collected and then processed into polyethylene and then processed into polypropylene (PP) and then made into chair seats. (# 5 plastic container code)	14. You are the oil (petroleum) gas called ethylene that is collected and then processed into polyethylene and then processed into polyvinyl chloride (PVC) and then made into plumbing pipes. (#3 plastic container code)

15. You are the oil (petroleum) gas called ethylene that is collected and then processed into polyethylene and then processed into polystyrene and then made into plastic foam meat trays. (# 6 plastic container code)	16. You are the oil (petroleum) gas called ethylene that is processed into polyethylene and then processed into polyethylene terephthalate (PET) and then made into a green soft drink bottle. (# 1 plastic container code)
17. You are the oil (petroleum) gas called ethylene that is collected and then processed into polyethylene and then processed into nylon and then made into toothbrush bristles.	18. You are the oil (petroleum) gas called ethylene that is processed into polyethylene and then processed into phenol formaldehyde and then made into dark-colored, heat-resistant saucepan handles.
19. You are the oil (petroleum) gas called ethylene that is collected and then processed into polyethylene and then processed into urea formaldehyde and then made into hard, colored bottle tops.	20. You are the oil (petroleum) gas called ethylene that is processed into polyethylene and then processed into melamine formaldehyde and then made into unbreakable plates and cups.
21. You are the oil (petroleum) gas called ethylene that is collected and then processed into polyethylene and then processed into polyester resin and mixed with glass to make fiberglass and then made into a canoe.	22. You are the oil (petroleum) gas called ethylene that is processed into polyethylene and then processed into melamine formaldehyde and then made into cutting boards for the kitchen.
23. You are rock that is quarried and processed into sand and gravel and then into concrete and then made into a cinder block for use in making a building.	24. You are limestone rock that is quarried and processed into blocks and made into a wall.

Earth, We Have A Problem, adapted (Handout)



In America, we cut down 1600 trees every minute to make paper.	It takes 90% less energy to recycle an aluminum can than to make a new one.
The energy saved by recycling one glass bottle, instead of making a new one, would power a light bulb for four hours.	Every ton of paper recycled can save 17 trees.
For us, this means that _____ _____.	One problem we see is _____ _____.

Explore/Explain

Green design individual reflection

I think the most important idea in green design is
_____.

What I like the most about green design is
_____.