The Home Environment

About this Unit

This unit takes students through several comparison studies of energy, water, and other resource consumption at home. A great deal of table reading and value input is involved in this unit. Another common element is dimensional analysis, which is the process of converting from one unit of measurement to another.

Students explore different reasons behind acting certain ways. Such reasons include economic, aesthetic and environmental values.

Materials used throughout the lessons include art supplies, computers with Internet access, poster paper, containers for holding and measuring water, and clean “trash.”

Contributing Writer

Ned Dorff

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Lessons included in this unit:

Lesson 1. Energy Use ......................................................... 7
   Skill Building: Table 1.1 (informational)
   Skill Building: Table 1.2 (informational)
   Skill Building: Calculation Practice
   Final Project: Your First Apartment

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   Skill Building: Gray Water

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   Skill Building: Hazards Present in Different Types of Insulation (informational)
   Skill Building: Lifespan of Insulation and R-Values (informational)
   Skill Building: Calculating Prices for Insulation
   Skill Building: Industry Supplement (informational)

Lesson 4. Lighting ......................................................... 27
   Skill Building: Types of Light bulbs (reading tables and comparing information)
   Skill Building: Comparing Yearly Savings
   Skill Building: Lighting Assessment
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Lesson 6.  Vampires and Phantom Loads  
**Skill Building:** Table 7.1 (informational, reading tables)  
**Skill Building:** Measuring Loads

Lesson 7.  Building Materials  
**Skill Building:** Examples of Different Building Materials (informational)  
**Skill Building:** Green Building Materials (informational)  
**Skill Building:** Calculating FSC Certified Wood Costs  
**Skill Building:** Sustainable Wood Suppliers in Wisconsin (informational)

Lesson 8.  Furnishing: Furniture and Carpeting  
**Skill Building:** Carpet and Furniture Choices (informational)  
**Skill Building:** Initial Costs of Flooring and Furniture Options (informational)  
**Final Project:** Furnishing Plan (calculating costs)

Lesson 9.  Second-hand Lifestyles  
**Skill Building:** Local Resource List (research skills)  
**Skill Building:** Disposal of Hazardous Materials (research skills)  
**Skill Building:** Saving Space in Landfills (using percent, dimensional analysis)  
**Final Project:** Poster Creation and Presentation
**Unit Vocabulary**

- **Ampere** – a unit of measurement of electric current; also called “amp”.
- **Appliance** – an object powered by electrical current.
- **Aesthetics** – the philosophy or study of the nature of beauty and art.
- **Biodegradable** – the ability to break down (decompose) physically or chemically in a natural setting.
- **Compact Fluorescent Light Bulb (CFL)** – a fluorescent light bulb that has been compressed into the size of a standard-issue incandescent light bulb. Modern CFLs typically last at least six times as long and use at most a quarter of the power of an equivalent incandescent bulb.\(^4\)
- **Coulomb** – a unit of electric charge. The amount of charge conveyed in one second by one ampere.
- **Data** – a collection of numbers or information.
- **Dimensional Analysis** – method of manipulating unit measures algebraically to determine the proper units for a quantity computed algebraically.
- **Disposal** – the action of ridding oneself of an item.
- **Donation center** – a place for people to drop off unwanted, reusable items.
- **Durability** – the ability of an item to last a long time without needing replacement or cost-prohibitive maintenance.
- **Energy efficiency** – the quantitative measure used to describe how low the amount of energy used is per unit of service provided.
- **Environmental values** – in this unit, a value system that places worth on sustainability and durability of goods.
- **Expenditure** – the total amount spent on items over time.
- **Extrapolation** – estimation of unknown values by extending or projecting from known values.
- **Fluorescent light bulb** – a light bulb that produces visible light by fluorescence, especially a glass tube whose inner wall is coated with a material that fluoresces when an electrical current causes a vapor within the tube to discharge electrons.\(^3\)
- **Gray water** – used water that is still safe for use on lawns and certain gardens, often originating in sinks, laundry machines, and showers/tubs.
- **Hazardous waste** – waste that can cause health problems to humans or wildlife, and/or chemical degradation of the environment.
- **Hazardous waste disposal site** – a location that takes in and handles waste harmful to human and environmental health.
- **Idle** – a state of disuse.
- **Incandescent light bulb** – a bulb lit by electricity passing through a filament that glows brightly with heat and light.
- **Initial costs** – the amount paid for an item up-front.
**Insulation** – a material that decreases the rate of heat transfer; the higher the R-value (resistance value), the better the insulation; a substance used to maintain warmth inside a building.

**Joule** – basic unit of thermal energy.

**Kilowatt** – 1,000 Watts.

**Kilowatt-hour** - the measure of energy used to power an item that draws 1 Kilowatt for a total of 1 hour.

**Landfills** – a place where trash is dumped; often trash is compacted and covered with layers of soil; sometimes gases that build up in landfills can be captured for energy use.

**Lifetime costs** – the amount paid for an item throughout its entire “life”; similar to long-term costs, includes initial cost, maintenance costs, replacement costs, disposal costs, and possibly environmental costs.

**Long-term costs** – the amount paid for an item over time; this usually includes initial cost, maintenance cost, and replacement cost.

**Long-term economics** – in this unit, a value that places worth on goods that will not require expensive replacement or maintenance over their lifetimes.

**Lumen** – A measure of how much light is put out by a bulb. Higher lumens mean a brighter bulb.

**Phantom load** – a phantom, or ghost, load is the amount of energy drained by an item when idle.

**R-Value** – resistance value; a measure of how well a material insulates, or resists heat transfer; R-value = temperature difference • area • time/heat loss.

**Recyclable** – an item is recyclable if it can be converted into something new and then be used.

**Reusable** – an item is reusable if it can be used again without being converted into something new.

**Short-term economics** – in this unit, a value that places worth on cheaply available goods.

**Sustainability** – a practice of doing things in a way that can be perpetuated indefinitely.

**Thrift store** – a thrift store is a place where people can purchase second-hand items.

**U-Values** – the inverse of R-Values; a measure of heat conductivity.

**Values** – beliefs; a way of determining worth of given practices.

**Vampire** – a vampire is an appliance that sucks energy even when idle.

**Volt** – a unit of electrical potential or pressure; one volt moves one coulomb of charge while using one joule of energy; can be related to water pressure.

**Waste stream** – the steady flow of varied wastes, from domestic garbage and yard wastes to industrial, commercial, and construction refuse.

**Watt** – a measure of power; equivalent to one ampere • one volt; equivalent to 1 joule of energy per second.

1[^whatis]: http://whatis.techtarget.com/definition/0,,sid9_gci1310981,00.htm

4[^Compact Fluorescent Light Bulbs]: http://www.energystar.gov/index.cfm?c=cfls.pr_cfls
Notes for unit planning:

- The gray water lesson can be instructed in two different ways. Both are explained in the lesson plan.
- Sources for information are included throughout the unit.
- Where notable, some of the vocabulary terms are in bold print within the lesson plan.
- There are many supplemental informational sheets provided on the topics presented. These sheets do not necessarily have to be given to students, but do provide valuable information and enhance the science aspect of the curriculum.
- All images are either from government sources or public domain.
- Be careful when using the words power and energy. Watt is a measure of power. When discussing watts, use the word power. When discussing kWh, use the word energy.

Content:
The math content in this unit is heavy in computation, data table reading, and dimensional analysis. Knowing how to find a percent of a whole number will help students achieve success. All articles are written by the author, unless otherwise noted.

Non-math concepts:
There is quite a bit of reading. The articles are generally short synopses of resource-use issues. There is poster creation and a presentation included in this unit.

Additional possibilities:
- Ideas for speakers include builders or retailers with experience in energy efficient/green technology.
- Students could start a wildflower garden at school and use the water collected in the gray water lesson.
- Explore the many aspects of energy-saving energy, safety, alternative energy, etc.: [http://www.energyquest.ca.gov/index.htm](http://www.energyquest.ca.gov/index.htm)
- Learn how to improve the energy efficiency in your home: [http://www.energyhog.org/](http://www.energyhog.org/)
- Take a tour around an energy efficient home: [http://www1.eere.energy.gov/kids/roofus/](http://www1.eere.energy.gov/kids/roofus/)

Dimensional Analysis
Dimensional analysis is a method used to convert from one unit to another through canceling out units.

**Fraction Example:** If you were multiplying $\frac{1}{2} \times \frac{5}{2} \times \frac{2}{7}$, set it up:

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{1}{2}$</td>
<td>$\frac{5}{2}$</td>
</tr>
<tr>
<td>$\frac{2}{7}$</td>
<td>$\frac{5}{2}$</td>
</tr>
</tbody>
</table>

The pairs of 2s and 5s cancel out. The problem is reduced to $\frac{1}{1} \times \frac{1}{7} \times \frac{1}{1} = \frac{1}{7}$

**Unit Example:** If you were converting 1 hour to seconds, set it up:

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hour</td>
<td>60 min</td>
</tr>
<tr>
<td>60 sec</td>
<td>1 min</td>
</tr>
</tbody>
</table>

The units cancel out. The problem is reduced to $1 \text{ hour} = 1 \times \frac{60 \text{ min}}{1 \text{ hour}} = 60 \text{ min}$
Learning Objectives

1. Students will estimate the amount of energy used in their daily lives.
2. Students will make choices regarding appliance purchases and determine how much energy they will use in a mock apartment.

Materials

- Skill Building pages, 1 per student

Hour 1

(5 min) Anticipatory Set: Turn off lights. Turn on lights. Ask the students what makes the lights work. Ask what else in the room consumes electricity.

(15 min) Presentation: Brainstorm a list of appliances at home that consume electricity.

- Skill Building: Power Draw tables of appliances and light bulbs
- Explain terms: watts, Kilowatts, Kilowatt-hour, phantom load

(20 min) Group Practice: Students will practice calculating the energy cost of various appliances over time.

- Skill Building: Calculation Practice
  Students will calculate kWh.
  Students will calculate kWh per day (sum of total energy used while running and while idle). To do this, they will multiply watts used while running • hours running/day, and they will multiply watts used while idle • hours idle/day and they will find the sum of the two numbers.
  Students will calculate kWh per week, month, year. To do this, they will take the answer from #4 and multiply it by 7 days/week; 30 days/month; 365 days/year, respectively.

(20 min) Independent Practice

- Skill Building: Your First Apartment
  Assessment: Students fill houses with 8-10 appliances from the energy use table and calculate energy use per day, week, and month.
  Students will multiply each total use by a standard cost for energy use. $0.10/kWh is an easy one to start with.
  Conclusion: Discussion questions: What appliances do we need? What appliances do we just want? What can/can’t we unplug when we’re not using it?
Table 1.1
Power Draw Averages Among Many Brands of Appliances

<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>Standby [Idle] (W)</th>
<th>Low Power [Sleeping] (W)</th>
<th>Active (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>Desktop</td>
<td>4.4</td>
<td>17.2</td>
<td>69.7</td>
</tr>
<tr>
<td></td>
<td>Laptop</td>
<td>1.0</td>
<td>3.1</td>
<td>21.9</td>
</tr>
<tr>
<td>Computer Monitor</td>
<td>CRT</td>
<td>1.8</td>
<td>2.5</td>
<td>70.3</td>
</tr>
<tr>
<td></td>
<td>LCD</td>
<td>1.1</td>
<td>1.7</td>
<td>27.0</td>
</tr>
<tr>
<td>Printer</td>
<td>Inkjet</td>
<td>1.7</td>
<td>3.2</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>Laser</td>
<td>1.3</td>
<td>9.6</td>
<td>39.0</td>
</tr>
<tr>
<td>Scanner</td>
<td>Flatbed</td>
<td>5.7</td>
<td></td>
<td>12.2</td>
</tr>
<tr>
<td>Hub</td>
<td>USB</td>
<td>1.1</td>
<td></td>
<td>2.8</td>
</tr>
<tr>
<td>Modem</td>
<td>Cable</td>
<td>4.5</td>
<td></td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>DSL</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Router</td>
<td>Wireless</td>
<td>1.7</td>
<td></td>
<td>6.2</td>
</tr>
<tr>
<td>Speakers</td>
<td>Computer</td>
<td>2.6</td>
<td></td>
<td>7.2</td>
</tr>
<tr>
<td>Television</td>
<td>CRT</td>
<td>3.2</td>
<td>33.1</td>
<td>73.0</td>
</tr>
<tr>
<td></td>
<td>LCD</td>
<td>2.2</td>
<td></td>
<td>69.9</td>
</tr>
<tr>
<td></td>
<td>Plasma</td>
<td>0.9</td>
<td></td>
<td>245.9</td>
</tr>
<tr>
<td>Television/DVD</td>
<td>CRT</td>
<td>3.0</td>
<td></td>
<td>36.5</td>
</tr>
<tr>
<td></td>
<td>LCD</td>
<td>2.2</td>
<td></td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>Plasma</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable/Satellite Box</td>
<td>Analog cable*</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>Digital cable*</td>
<td>26.4</td>
<td>26.4</td>
<td>26.4</td>
</tr>
<tr>
<td></td>
<td>Digital cable with DVR*</td>
<td>43.0</td>
<td>43.0</td>
<td>43.0</td>
</tr>
<tr>
<td></td>
<td>DVR*</td>
<td>36.7</td>
<td>36.7</td>
<td>36.7</td>
</tr>
<tr>
<td></td>
<td>Satellite</td>
<td>12.3</td>
<td>11.1</td>
<td>16.0</td>
</tr>
<tr>
<td></td>
<td>Satellite with DVR</td>
<td>24.8</td>
<td>27.6</td>
<td>33.6</td>
</tr>
<tr>
<td>VCR</td>
<td></td>
<td>2.4</td>
<td>7.4</td>
<td>13.2</td>
</tr>
<tr>
<td>DVD Player</td>
<td></td>
<td>1.0</td>
<td>5.0</td>
<td>10.8</td>
</tr>
<tr>
<td>Game Console</td>
<td></td>
<td>1.0</td>
<td></td>
<td>24.2</td>
</tr>
<tr>
<td>CD Player</td>
<td></td>
<td>1.3</td>
<td></td>
<td>6.7</td>
</tr>
<tr>
<td>CD Recorder</td>
<td></td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radio</td>
<td></td>
<td>1.5</td>
<td>2.2</td>
<td>11.6</td>
</tr>
<tr>
<td>Portable Stereo</td>
<td></td>
<td>1.6</td>
<td>6.3</td>
<td>8.2</td>
</tr>
<tr>
<td>Garage Door Opener</td>
<td></td>
<td>4.8</td>
<td></td>
<td>108.0</td>
</tr>
<tr>
<td>Water Dispenser</td>
<td></td>
<td>100.2</td>
<td></td>
<td>628.0</td>
</tr>
<tr>
<td>Coffee Maker</td>
<td></td>
<td>1.5</td>
<td></td>
<td>182.5</td>
</tr>
<tr>
<td>Clock</td>
<td>With Radio</td>
<td>5.4</td>
<td>3.1</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td>Without Radio</td>
<td></td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>Chargers</td>
<td>CD Player</td>
<td>0.8</td>
<td>1.4</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>Cell Phone</td>
<td>0.2</td>
<td>0.5</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>Digital Music Player*</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>Still Camera</td>
<td></td>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Portable TV/Video Camera</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Indicates that usage was not differentiated between idle, low power or active
## Table 1.2

*Power Draw For Light Bulbs*

<table>
<thead>
<tr>
<th>Type of bulb</th>
<th>Wattage</th>
<th>Lumens</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL – EPA averages</td>
<td>10</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>1,100</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>1,600</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>2,600</td>
</tr>
<tr>
<td>Incandescent- EPA averages</td>
<td>40</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>1,100</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>1,600</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>2,600</td>
</tr>
</tbody>
</table>

Calculation Practice

Remember: Show your work and make sure you use the correct label on all your answers!

Directions: Find the energy cost savings by switching from Old Junker Co. appliances to Average 2006 brand. When using Average Brand data, round to the nearest 1 W. For example, if it is 2.4 W, round down to 2; if it is 36.5 W round up to 37 W.

You are choosing between two types of computers: Old Junker computer and Average 2006 computer.
- Old Junker desktop computer power draw while on: 100 W
- Average 2006 desktop computer power draw while on: 70 W.

Example. Use dimensional analysis to determine the amount of money you would spend per year if you used the Old Junker computer for 40 hours/wk and energy cost $0.10 per kWh (also written $0.10/kWh). Set it up like this:

<table>
<thead>
<tr>
<th>Step 1</th>
<th>100 W</th>
<th>1 kW</th>
<th>40 hrs</th>
<th>$0.10</th>
<th>4.4 weeks</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,000 W</td>
<td>1 week</td>
<td>1 kW</td>
<td>1 month</td>
<td>1 year</td>
<td></td>
</tr>
</tbody>
</table>

Cancel out the units:

<table>
<thead>
<tr>
<th>Step 2</th>
<th>100 W</th>
<th>1 kW</th>
<th>40 hrs</th>
<th>$0.10</th>
<th>4.4 weeks</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,000 W</td>
<td>1 week</td>
<td>1 kW</td>
<td>1 month</td>
<td>1 year</td>
<td></td>
</tr>
</tbody>
</table>

Note: kW • hrs = kWh

Multiply the remaining numbers and units across:

<table>
<thead>
<tr>
<th>Step 3</th>
<th>100 W</th>
<th>1 kW</th>
<th>40 hrs</th>
<th>$0.10</th>
<th>4.4 weeks</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,000 W</td>
<td>1 week</td>
<td>1 kW</td>
<td>1 month</td>
<td>1 year</td>
<td></td>
</tr>
</tbody>
</table>

= $21.12/year

1. Using dimensional analysis, calculate energy usage from average 2006 computer for 40 hours a week.

    | 70 W | 1 kW | 40 hrs | $0.10 | 4.4 weeks | 12 months |
|-----|------|--------|-------|-----------|-----------|
|    | 1,000 W | 1 week | 1 kW | 1 month | 1 year |

2. Subtract to find the cost savings of moving to a Average 2006 desktop computer.

3. Compare the Old Junker Computer (100 W while active) to an Average 2006 laptop computer. Use Table 1.1 to find the wattage of a laptop computer while active. Determine the cost savings over the course of the year if a person switched from the Old Junker to the Average 2006 laptop.
Your First Apartment!

Directions: Use the table 1.1 to fill in this house with appliances. Write the name of the appliance on the floor plan, and next to it write how many hours it will be used per day. Calculate the total daily energy usage of your house in kWh while the items are active.

Using dimensional analysis, all of the conversions would be set up like this:

$$\frac{\text{W}}{1 \text{ kW}} \times \frac{1 \text{ hrs}}{1,000 \text{ W}} \times \frac{\$0.10}{\text{kWh}} = \$\,\text{____/day}$$

If you use more than one of the same appliances (e.g., light bulbs), multiply the above number by the amount of appliances you are using.

<table>
<thead>
<tr>
<th>Bedroom</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Living Room</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bathroom</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kitchen</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Extension 1.** Calculate the idle power draw of the appliances in your house (when they are turned off)

**Extension 2.** Calculate the amount of money spent monthly on electricity at $0.10/kWh for the above power draw.
The Home Environment

Lesson Plan

Water Use | Lesson 2

Learning Objectives

1. Students will estimate daily, weekly, monthly and yearly water usage at home.
2. Students will choose hypothetical ways to reduce water usage.
3. Students will practice the use of water collection and redistribution, measuring total volume of water reused in one day.
4. Students will define gray water and determine possible ways to implement the practice at home and school.

Materials

- Graduated container to measure liquid volume
- Water collector
- Sink
- Biodegradable soap: ingredients to avoid are sodium, chlorine, and boron
- Large chart paper to graph use
- Sink
- Toilet
- Timer(s)
- Graduated container to measure liquid volume
- Skill Building: Appliance Water Usage Chart, 1 per student

Preparation

1. Collect water for Hour 2 (gray water) one day prior to the lesson.

Hour 1

(5 min) Setting the Stage: Take students to a sink and turn it on. Let it run for a while. Turn it off. Ask students if they had any feelings or questions while watching you let a bunch of water run without using it.

(10 min) Presentation: Explain that students will be calculating their personal daily water usage. They will calculate their water use during hand washing, toilet flushing, showering, dish washing, and use of washing machine. Display the container(s) and times that you will use in this experiment to measure water use.

(20 min) Group Practice

Part One: How long does it take to use a gallon?
Class demonstration.

You will be determining an estimate of how long it takes to use a gallon (or alternative measure of volume, e.g., Liter) of water.

Procedure:

1. Teacher will turn on the tap to a normal hand washing flow.
2. Selected students will time how long it takes to fill up the gallon container.

To account for discrepancies among the students' times, an average should be determined. To find the mean (average), add all times together and divide by number of times. Your answer should have the label seconds/gallon.

3. Over the course of three trials, the teacher and students will determine an average time it takes to use a gallon of water while washing hands.
4. Students and teacher will calculate the average together using the formula:

\[ \frac{\text{Avg. Trial 1} + \text{Avg. Trial 2} + \text{Avg. Trial 3}}{3} = \text{seconds/gallon} \]

Part Two: How long do we take to wash our hands?
Class demonstration.

Display the timers students will use to time their hand washing.

Procedure:

1. Selected students will time how long it takes the teacher to wash his hands teacher over three trials.
2. Again, find the mean (average). Find the sum of the times and divide by number of times used. Your answer should be in seconds/gallon.
(5 min) Independent Practice:

Put students in groups of three.

**Students will time each other as they wash hands.** The two students not washing hands should time the student washing hands. They will record their numbers and take an average of all time trials.

\[
\text{Avg. Trial 1 + Avg. Trial 2 + Avg. Trial 3} \over 3 = \text{_____ seconds/gallon}
\]

(10 min)

**Part Three: Estimating: How much water do we use when we wash our hands?**

Students will be calculating how much water is used per hand wash. After this, it will be easy to extrapolate the data for total daily, weekly, and yearly use.

The calculation to determine water use per hand wash is this:

Time per hand wash (seconds/wash) • inversion of time it takes to use a gallon (Gallons/seconds)

\[
\frac{\text{Time per hand wash}}{1 \text{ wash}} \times \frac{1 \text{ Gallon}}{1 \text{ seconds}} = \text{_____ gallons/wash}
\]

Students will practice dimensional analysis (canceling units). Seconds will cancel out seconds, and they’ll be left with a unit of volume (in this case, gallons) per wash.

**Part Four: How much water do we use per day/week/year to wash hands?**

To calculate water use per day, students should estimate how many times they wash hands during the day (eg. after toilet use, before meals).

Students take their number of hand washes/day and multiply it times volume/wash.

The calculation will be: wash/day X volume/wash

\[
\frac{\text{number of hand washes}}{1 \text{ day}} \times \frac{\text{_____ gallon}}{1 \text{ wash}} = \text{_____ gallon/day}
\]

Through proper cancellation of labels, students will end up with volume/day

**Part Five: Calculating water flushed down the drain (toilet, shower, dish washing, laundry)**

Procedure:

1. Distribute **Skill Building: Appliance Usage Chart** showing volume/time for various appliances- toilets, dishwashers, and washing machines.
2. Students should calculate how many times per day or week they use each of these appliances.

Using previous methods, students can calculate how much water they use by employing these devices.

- **To calculate laundry water use:** volume/use • uses/week
- **To calculate toilet use:** volume/flush • flushes/day
  (if too embarrassing of a topic, students can use 4 flushes/day as an average)
- **To calculate shower use:** volume/minute • minutes/shower
- **To calculate dish washing use:** volume/wash • washes/week
Assessment

1. Using dimensional analysis, have students show how much water they use on a yearly basis for each type of use. Then have them find the sum of all their usage.

Calculations should include:

\[
\text{Volume/Day} \times 365 \text{ Days/Year} = \text{Volume/Year}
\]

\[
\frac{\text{Volume}}{\text{Day}} \times 365 \text{ days/year} = \text{Volume/year}
\]

\[
\text{Volume/Week} \times 52 \text{ Weeks/Year} = \text{Volume/Year}
\]

\[
\frac{\text{Volume}}{\text{Week}} \times 52 \text{ weeks/year} = \text{Volume/year}
\]

2. Further assessment could ask them to extrapolate from their data to calculate the data for their entire family/class/school. Alternatively, they could poll people to gather new data and make new averages before extrapolating for total use.

The calculation for this should be:

\[
\text{Volume/Year} \times \text{Number of People} = \text{Volume per People/Year}
\]

\[
\frac{\text{Volume}}{\text{Year}} \times \# \text{ People} = \text{volume per people/year}
\]

Hour 2

(5 min) Setting the Stage: Wash your hands in front of the class. (or have selected student(s) do this). Ask students where this water goes (treatment center), and why it goes there (to be cleaned).

Ask students if there may be another use for this water, or if something would prevent it from being used before treatment.

(20 min) Presentation: Inform students that they will be learning about a new way to use waste water.

**Skill Building: Gray water Guidelines**

Display biodegradable soap.

Direct students to take out their water data from the previous lesson.

(30 min) Group Practice:

Procedure:
1. Students will calculate all the water they use to do laundry, wash dishes, and wash hands in a week.
2. Students find the sum of these numbers.
3. Take several examples from students and use them to find an estimated class average. To do this, add up the sums from each student and divide by number of sums used. This should give you an answer in: student volume/week.
4. This number is your estimate of how much water could be used to water lawns/flower gardens instead of being sent to the waste treatment plant to be treated with chemicals.
Hour 3

You will be determining how much water could be used from your classroom/school sinks. This is similar to the experiment in Hour 1. That data could be used here instead of new calculations.

You will decide to collect this information in one of two ways. Either collect total water or estimate the data.

If you are estimating the data of total water used for washing hands at school:

1. Determine a total amount of hand washes/day for your students and yourself.
2. Determine how long it takes to fill a certain quantity (gallon, liter, etc.)
3. Find an average amount of time used during hand washes.
4. Determine through calculations how much water is used per day from your class washing hands.
5. Many of these calculations are spelled out in Lesson II.

If you are collecting water instead, you will need to do some other work:

1. To collect water from hand washing, make sure students use biodegradable soap. That way, the water they use can actually be used on the land.
2. For each hand wash, students should use a receptacle to catch as much water as possible during their hand washing. If they need more than one receptacle, that may prove tricky, but can be done.
3. Students now have the option of measuring their total water use and dumping it into the drain, or taking it to a predetermined spot on campus to pour out.
4. Students will mark how much water they used on a piece of graph paper. Each time a student uses water, he/she will add his total to the graph. A bar graph works best for this. It may be necessary to use multiple pieces of large graph paper throughout the day.
5. At the end of the day, students will total how much water was used washing hands.
6. Ask them if their data are accurate. What were some possibilities for error entering into their data (spilled water, inaccurate measurement).
7. Ask them if their data are useful. (Yes, because they provide an estimate).

Extension

Students can make posters showing their calculations and total water use. They can put ideas on the poster for reducing water use.
Appliance Water Usage Chart

According to the American Water Works Association, each person in the USA uses 94 gallons of water indoors every day! Let’s look at some of the appliances that use that water.

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Type</th>
<th>Gallons per use</th>
<th>Gallons per minute</th>
<th>Gallons per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dishwasher</td>
<td>Efficient</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaky faucet</td>
<td>10 drips/min</td>
<td></td>
<td>43</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 drips/min</td>
<td></td>
<td>130</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 drips/min</td>
<td></td>
<td>260</td>
<td></td>
</tr>
<tr>
<td>Toilet</td>
<td>Old (pre-’78)</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conventional (’78-93)</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low-flow (’94 to present)</td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shower head</td>
<td>Conventional</td>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low-Flow</td>
<td></td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Faucet</td>
<td>Conventional (pre-’78)</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low-Flow</td>
<td></td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Washing machine</td>
<td>Top-loader</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Front-loader</td>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gray Water Guidelines

1. First and foremost, avoid human contact with gray water.
2. CAUTION: In some areas, reuse of water is either prohibited by health officers and/or plumbing inspectors, or requires an inspection and permit. Make sure that it is legal in your area before setting up a gray water collection site in your home!
3. You may use gray water for household gardening, composting, and lawn and landscape irrigation, but it should not run off your property.
4. Do not surface irrigate any plants that produce food, except for citrus and nut trees.
5. Use only flood or drip irrigation to water lawns and landscaping. Spraying gray water is prohibited.
6. When determining the location for your gray water irrigation, remember that it cannot be in a wash or drainage way.
7. Gray water may only be used in locations where groundwater is at least five feet below the surface.
8. Label pipes carrying gray water under pressure if confusion between gray water and drinking water pipes is possible.
9. Cover, seal, and secure storage tanks to restrict access by small rodents and to control disease-carrying insects.
10. Hazardous chemicals such as antifreeze, mothballs, and solvents, cannot be in gray water. Do not include wash water from greasy or oily rags in your gray water.
11. Gray water from washing diapers or other infectious garments must be discharged to a residential sewer or other wastewater facility, or it can be disinfected prior to its use.
12. Surface accumulation of gray water must be kept to a minimum.
13. Should a backup occur, gray water must be disposed into your normal wastewater drain system. To avoid such a backup, consider using a filtration system to reduce plugging and extend the system's lifetime.
14. If you have a septic or other on-site wastewater disposal system, your gray water use does not change that system's design requirements.
15. Apply gray water directly to the soil, not through a sprinkler or any method that would allow contact with the above ground portion of the plants.
16. Root crops that are eaten uncooked should not be irrigated with gray water.
17. Plants that thrive only in acid soil should not be watered with gray water, which is alkaline.
18. Use gray water only on well-established plants, not seedlings or young plants.
19. Disperse gray water over a large area, and rotate with fresh water to avoid buildup of sodium salts.

Sources:
Learning Objectives

1. Students will describe several types of insulation.
2. Students will evaluate insulation based on several criteria, including sustainability, health impacts, durability, and efficiency.
3. Students will compare costs and benefits of using several different types of insulation to insulate a mock house.

Materials

- Pictures or samples of insulation
- Skill Building: Insulation, 1 per student
- Cost tables per sq/cubic ft of insulation
- DOE chart and map This needs to be printed or projected in color!
- List of chemicals/pollutants present in different types of insulation
- Table of performance quality of types of insulation

Hour 1

Reading and Evaluation

(10 min) Setting the Stage: Display several examples of insulation from Skill Building: Insulation handout. Ask students what insulation is and what people use it for.

(20 min) Presentation: Explain to students that they will be learning about how insulation is manufactured, what it does for the energy efficiency of a building, and how there are different environmental and economic costs and benefits of different types of insulation.

Skill Building: Insulation. Read as whole group.

Display Department of Energy Visuals—this needs to be printed or projected in color! Ask students to identify the zone you are in. Read through R-Values for various parts of the home.

Distribute R-Values by type. Ask students why people might choose to use or avoid certain types of insulation, depending on their values.

Hour 2

Compare Costs and Benefits

Assessment

Calculating prices for different types of insulation. Help students get started with reading the table, if necessary.

Note to teacher:

The popular Green Fiber cellulose insulation is not mentioned in the article but is included on the Skill Building: Calculating Prices sheet.

References:

1. http://www.urbanecologycenter.org/ samples of insulation can be found here
Insulation

Heating and cooling are significant costs to renters and homeowners. The monthly utility bill is one of the largest bills paid by families. To save money on heating and cooling, homes are constructed with insulating techniques. Different types of insulation include the minerals vermiculite and asbestos, natural products like cellulose from cotton, hemp or flax, and fiberglass, which is the most common type of insulation used in the US. The quality of insulation depends mainly on its R-Value, a measure of how well it resists heat transfer. The higher the R-Value, the more water-resistant the insulation.

Other considerations for purchasing insulation are the health effects. People have suffered various diseases from inhaling disturbed asbestos and fiberglass. In fact, asbestos inhalation is known to cause lung failure and cancer in the chest and abdomen.

Another consideration for purchasing insulation is how the production of the insulation affects the environment. Vermiculite must be mined. Fiberglass insulation is constructed from spun-glass, some of which is post-consumer recycled glass. However, the resin in the backing contains petrochemicals. Natural alternatives are becoming more popular as people seek to use more environmentally friendly products.

Types of Insulation

What is vermiculite insulation?

Vermiculite is a naturally occurring mineral that has the unusual property of expanding into worm-like accordion shaped pieces when heated. The expanded vermiculite is a light-weight, fire-resistant, absorbent, and odorless material. These properties allow vermiculite to be used to make numerous products, including attic insulation.


What is asbestos insulation?

Naturally occurring asbestos (NOA) includes fibrous minerals found in certain types of rock formations. NOA can take the form of long, thin, separable fibers. Natural weathering or human disturbance can break NOA down to microscopic fibers, easily suspended in air. There is no health threat if NOA remains undisturbed and does not become airborne. When airborne NOA is inhaled, these thin fibers irritate tissues and resist the body’s natural defenses. Asbestos, a known carcinogen, causes cancers of the lung and the lining of internal organs, as well as asbestosis and other diseases that inhibit lung function. Covering NOA with clean soil or planting grass reduces exposure.

Skill Building

What is spray polyurethane insulation?
Currently, spray polyurethane foam is made with a stratospheric ozone depleting chemical, HCFC-141b, which is being phased out of production in the United States in accord with the Clean Air Act and the Montreal Protocol. An EPA grant will assist the spray polyurethane foam industry to safely convert to alternative technologies that are economically viable and provide energy-efficient products for consumers.

Spray Polyurethane foam Photo: Guardian Foam Insulation
http://guardianfoaminsulation.com/friendlyfoam.htm


What is soy-based insulation?
Soy-based insulation is relatively new on the market. Industry leaders claim that it is healthier than other types of insulation, while providing the same high quality insulating that other types provide. Tests have determined that soybean insulation does not contain formaldehyde, or emit dangerous volatile organic compounds or other toxic emissions.

Soybean foam Photo Source: Kentucky Soybean Products
http://www.kysoy.org/kysoyproducts.htm

Text sources: Home Garden TV http://www.hgtvpro.com/hpro/dj_technology/article/0,,HPRO_20157_3679395,00.htm

BioBased Spray Foam Insulation www.biobased.net

What is fiberglass insulation?
While in most cases, fiberglass insulation has been safe for family use, it can release tiny particles that have been linked to respiratory illnesses. Pink fiberglass has been used by millions of Americans to provide insulation and resist moisture in their homes and attics.

Pink Fiberglass Photo source:

Text Sources:
### Insulation Zone Table: US DOE

[Insulation Zone Table: US DOE](http://www1.eere.energy.gov/consumer/tips/insulation.html#chart)

### Zone map: Source US DOE [Insulation Zone Table: US DOE](http://www1.eere.energy.gov/consumer/tips/insulation.html#map)
## Hazards present in different types of insulation

<table>
<thead>
<tr>
<th>Insulation Type</th>
<th>Hazards</th>
<th>How exposure occurs</th>
<th>Symptoms of exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fiberglass</strong></td>
<td>Disturbed fiberglass particles</td>
<td>Inhalation</td>
<td>Respiratory illnesses, coughing, scratchy throat</td>
</tr>
<tr>
<td></td>
<td>Fiberglass particles</td>
<td>Direct skin contact</td>
<td>Skin, eye, nose, and throat irritation</td>
</tr>
<tr>
<td><strong>Soy, cotton, hemp, hay, and flax-based cellulose, or foam</strong></td>
<td>Possible allergen (although soy, hemp, flax are produced non-allergenic, and no pollen is left in hay insulation, which uses only the stalks)</td>
<td>Direct contact, inhalation</td>
<td>Skin, eye, nose, throat irritation</td>
</tr>
<tr>
<td><strong>Soy, cotton, hemp, hay, and flax-based cellulose, or foam</strong></td>
<td>Possible exposure to agricultural chemicals used to grow the plants</td>
<td>Direct contact, inhalation</td>
<td>??</td>
</tr>
<tr>
<td><strong>Asbestos</strong></td>
<td>Disturbed asbestos particles</td>
<td>Inhalation</td>
<td>Lung cancer, Mesothelioma (chest and abdominal lining cancer), Asbestosis (lung scarring and impairment)</td>
</tr>
<tr>
<td></td>
<td>Disturbed asbestos particles</td>
<td>Skin contact</td>
<td>Asbestos warts</td>
</tr>
<tr>
<td><strong>Vermiculite</strong></td>
<td>Widespread asbestos contamination from main vermiculite mining site in MT</td>
<td>See asbestos</td>
<td>See asbestos</td>
</tr>
<tr>
<td><strong>Polyurethane foam insulation</strong></td>
<td>Ozone layer-depletion</td>
<td>Chemicals emit from insulation</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Sources: American Lung Association [www.lungusa.org](http://www.lungusa.org), US EPA [www.epa.gov](http://www.epa.gov)
Lifespan of insulation

Cellulose, fiberglass, and foam used in insulation materials will last a lifetime provided that they are not punctured, cut, or burned; are kept dry; and are not subjected to UV rays. This pertains whether the insulation was applied as loose fill, house wrap or batts and rolls.

Department of Energy R-Value Recommendations

To find the suggested R-Values for different areas in your home, go to US Department of Energy Website: http://www1.eere.energy.gov/consumer/tips/insulation.htm

Click on the map, chart or the calculator and find the recommended R-Values for different areas of your home.

R-Value Performance of Insulation Types

<table>
<thead>
<tr>
<th>Type</th>
<th>R-Value per inch thickness, minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood chips</td>
<td>R-1</td>
</tr>
<tr>
<td>Air pocket</td>
<td>R-1</td>
</tr>
<tr>
<td>Straw</td>
<td>R-1.45</td>
</tr>
<tr>
<td>Fiberglass batt panel</td>
<td>R-2</td>
</tr>
<tr>
<td>Vermiculite, loose fill</td>
<td>R-2.1</td>
</tr>
<tr>
<td>Fiberglass, loose fill</td>
<td>R-2.2</td>
</tr>
<tr>
<td>Fiberglass panel</td>
<td>R-2.5</td>
</tr>
<tr>
<td>Cellulose loose-fill or wet spry</td>
<td>R-3</td>
</tr>
<tr>
<td>Polyethylene foam</td>
<td>R-3</td>
</tr>
<tr>
<td>High-density fiberglass batts</td>
<td>R-3.6</td>
</tr>
<tr>
<td>Polyurethane spray foam, open cell</td>
<td>R-3.6</td>
</tr>
<tr>
<td>Cotton batts (from old blue jeans)</td>
<td>R-3.7</td>
</tr>
<tr>
<td>Expanded polystyrene batt</td>
<td>R-4.0</td>
</tr>
<tr>
<td>Extruded Polysterene batt</td>
<td>R-5.0</td>
</tr>
<tr>
<td>Polyurethane spray foam, closed cell</td>
<td>R-5.5</td>
</tr>
<tr>
<td>Polyurethane panel, non CFC/HCFC</td>
<td>R-6.8 (R-5.5 aged 5 years)</td>
</tr>
<tr>
<td>Polyurethane panel, CFC/HCFC</td>
<td>R-7 (R6.25 aged 5 years)</td>
</tr>
</tbody>
</table>

Performance quality of types of insulation per millimeter (mm) thickness*

<table>
<thead>
<tr>
<th>Type of Insulation</th>
<th>R1.0</th>
<th>R1.5</th>
<th>R2.0</th>
<th>R2.5</th>
<th>R3.0</th>
<th>R3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulose fibre loose fill</td>
<td>40</td>
<td>60</td>
<td>80</td>
<td>100</td>
<td>120</td>
<td>140</td>
</tr>
<tr>
<td>Glass fibre batt</td>
<td>44</td>
<td>66</td>
<td>88</td>
<td>110</td>
<td>132</td>
<td>154</td>
</tr>
<tr>
<td>Polyester or wool blanket</td>
<td>45</td>
<td>68</td>
<td>90</td>
<td>113</td>
<td>135</td>
<td>158</td>
</tr>
<tr>
<td>Polystyrene expanded</td>
<td>39</td>
<td>59</td>
<td>78</td>
<td>98</td>
<td>117</td>
<td>137</td>
</tr>
<tr>
<td>Polystyrene extruded</td>
<td>28</td>
<td>42</td>
<td>56</td>
<td>70</td>
<td>84</td>
<td>98</td>
</tr>
<tr>
<td>Rockwool batt</td>
<td>28</td>
<td>42</td>
<td>56</td>
<td>83</td>
<td>99</td>
<td>116</td>
</tr>
<tr>
<td>Wool (80%) Polyester (20%) batt</td>
<td>45</td>
<td>68</td>
<td>90</td>
<td>113</td>
<td>135</td>
<td>158</td>
</tr>
</tbody>
</table>

*Important Note: R-Value does not necessarily change linearly. This means that 2-inch thick material may not have exactly twice the R-Value of one-inch thick insulation. Also, R-Value will often decrease if an insulation type is compressed.

Sources:
Calculating Prices for Insulation

Remember: Show your work and make sure you use the correct label on all your answers!

Directions: Use the information in the table to solve the following problems.

<table>
<thead>
<tr>
<th>Type</th>
<th>Size/Amount</th>
<th>Cost/unit</th>
<th>Amt needed to cover 1 sq ft at R-Value 30</th>
<th>Area covered per unit at R-Value 30</th>
<th>Units needed for 1000 sq ft at R Value of 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Fiber Natural Fiber</td>
<td>22.5 lbs (1 bag)</td>
<td>$5.74/bag</td>
<td>0.043 bags</td>
<td>23.25 sq ft/bag</td>
<td>43 Bags</td>
</tr>
<tr>
<td>Owens Corning Pink Fiberglass</td>
<td>1 roll (50 sq ft)</td>
<td>$40.00/50 sq ft roll</td>
<td>0.050 rolls</td>
<td>50 sq ft/roll</td>
<td>50 Rolls</td>
</tr>
<tr>
<td>US Green Fiber Cellulose</td>
<td>1 bag</td>
<td>$5.33/bag (23 sq ft)</td>
<td>0.044 bags</td>
<td>23 sq ft/bag</td>
<td>44 Bags</td>
</tr>
</tbody>
</table>

Sources: [www.homedepot.com](http://www.homedepot.com), [www.acehardware.com](http://www.acehardware.com), [www.lowes.com](http://www.lowes.com), June 27, 2008

1. How much would it cost to insulate a 1,000 square foot home with Green Fiber natural fiber at an average R-Value of 30?

2. How much would it cost to insulate a 1,000 square foot home with Owens Corning fiberglass insulation?

3. How much would it cost to insulate a 1,000 square foot home with US Green Fiber cellulose insulation?

4. Order the insulation from the least expensive to most expensive option for insulating a 1000 square foot home with an average R-Value of 30.
Industry Supplement

This is the content from the web page of an insulation supplier, ComforTemp, based in Texas. On their page, they attempt to describe the differences among three types of insulation: cellulose, fiberglass, and polyurethane/soy combination foam. Notice that the company focuses on many features besides R-Value.

Types of Insulation

Cellulose

R-Value & Air Infiltration
Uncontrolled air leakage through exterior walls and ceilings of homes is as important as R-value in determining how much energy will be required to heat and cool a home. Infiltration of outside air means that heating and cooling systems must work harder and expend more energy.

To help prevent air leaks, ComforTemp applies cellulose insulation to exterior walls and attics. In addition to it's high R-Value, cellulose insulation is very dense (2-3 times as dense as mineral fiber), so air will not pass through it like other insulations. In addition, by spray-applying cellulose insulation, every nook and cranny of every wall cavity is completely filled right to the edge of the stud. Penetrations are blocked, pipes and wires are encapsulated, and window frames and electrical outlets are totally sealed.

Water Vapor Absorption
Moisture problems are usually caused by moist air moving into exterior walls and condensing. With high-density cellulose insulation, moist air infiltration is effectively blocked. In fact, many building authorities believe that with cellulose insulation in the exterior walls, barriers such as house wraps are unnecessary because cellulose insulation does as good a job as house wraps in preventing outside air and moisture from entering the house.

Pest & Insect Resistance
A beneficial side effect of the boron-based chemicals incorporated into cellulose insulation for fire retardancy, is it’s safe and natural ability to help protect homes against mold, mildew, insects and other pests.

Convection
In the winter, the warm air inside a house rises against the ceiling with considerable pressure. Without proper protection, some of this warm air finds its way into the attic to be replaced by colder air in the living spaces. With it’s greater density, cellulose insulation seals in a home’s warm interior air, preventing heat loss in the winter.

Fiberglass

Why Fiberglass?
Although lacking in some of the advantages of cellulose, when properly installed, fiberglass is an effective and economical insulation alternative in areas that are too difficult to reach with spray-applied cellulose. These areas typically include cathedral or sloped ceilings, cold floors, and inaccessible attic floors.

While it is possible to use cellulose insulation in these areas by using specialized application techniques, the benefits are often outweighed by the additional cost of installation labor. Working with you, ComforTemp’s trained insulation specialists will determine the appropriate insulation system to meet any construction challenge.
Polyurethane Soy Foam

*Soy Foam* spray-in-place polyurethane foam insulation is a two-part soybean based polyurethane. This specially developed product is an excellent thermal and acoustical insulation product when applied by trained and certified installers. *Soy Foam* expands in the wall or the roof cavity to completely fill all spaces and therefore is a highly efficient seal against air infiltration, the number one source of energy loss. In a direct comparison to products using cellulose and fiberglass, *Soy Foam* provides superior quality and performance. It is equally ideal for use in both residential and commercial construction applications.

*Soy Foam* insulation is an open cell, semi-rigid foam that in one step provides a sealed thermal envelope that can simplify construction practices. *Soy Foam* adheres to any clean dry surface, completely fills any cavities and forms a continuous barrier against any potential air leaks. It provides any domestic or commercial building with substantially reduced energy costs combined with a cleaner, more comfortable environment. Using *Soy Foam* insulation systems also allows the use of smaller, less expensive heating and cooling equipment. Use of properly sized HVAC equipment reduces energy consumption and prevents moisture buildup within the structure. The resulting increased energy efficiency is a significant cost-reducing factor in most buildings.

*Soy Foam* provides a healthier indoor environment. It can eliminate building wrap, caulking and taping, and the labor-intensive work associated with air-tightness detailing, required when insulating with conventional products. Proper ventilation of tightly sealed building allows for the first time, the ability to control indoor air quality.

*Soy Foam* has significant advantages over conventional insulation materials such as fiberglass and cellulose. It permanently and completely fills and seals all voids. *Soy Foam* offers better overall thermal performance at nearly the same net cost as other products. Fiberglass or cellulose cannot seal from stud to stud or around outlets, since these materials can settle. In addition fiberglass and cellulose can lose their insulation value if water or moisture invades the wall cavity. *Soy Foam* is not affected by time or moisture influence, it will not settle, it is completely resistant to mold and mildew, and it offers no food source or nesting materials for rodents and insects.

*Soy Foam is available in a 0.5 lb. and 1.7 lb. density formula

*Soy Foam* 750 is our 0.5 lb. open-cell product and is widely used in wall cavities, attics, and under floors. It is also used in interior walls for sound proofing applications. The R-value for this product is 3.78 per inch yielding an effective R-13 in a 3.5” stud wall.

*Soy Foam* 17000, our 1.7 lb. closed-cell is used where a higher R-value is required by local codes or customer preferences. The R-value of this product is 6.8 per inch yielding an effective R-24 in a 3.5” wall stud. BioBase 1700 provides as good or better insulation with a 3.5” stud exterior wall as traditional insulations do with a 6” stud construction. BioBase 1700 with 3.5” studs will provide greater living area and will significantly reduce billing costs by eliminating the need for the more expensive 6” studs, windowsills and door jams, thereby providing additional living area.

*Soy Foam 750 & 1700 insulation systems provides superior performance

- Reduced HVAC loading
- Heating and cooling costs decreased
- Seals and insulates in on application
- Provides a draft free environment for improved indoor air quality
- Reduction in airborne dusts and fibers
- Reduced indoor and outdoor acoustical pollution
- R-values do not deteriorate over time
- Does not settle or compact in cavities

Learning Objectives

1. Students will describe several types of lighting options.
2. Students will compare and contrast lighting options based on aesthetics, energy efficiency, durability and disposal/health concern.
3. Students will compare financial costs and benefits of using different types of light bulbs.

Materials

- Visuals or samples of different light bulbs
- Skill Building pages, one per student

Hour 1

(5 min) Setting the Stage: Display different types of light bulbs and ask students if they can explain anything about any of them.

(20 min) Presentation and Group Practice

Direct students to take notes on the following terms: incandescent, compact fluorescent, energy efficiency.

Skill Building: Pros and Cons of CFL vs. Incandescent.
Skill Building: Types of Light bulbs. Read the articles as a class. Focus on concepts of light quality, up-front cost, long term cost, and disposal issues.

Extension: Read Handling Broken CFL Bulbs and the How to Choose chart

Skill Building: Comparing Yearly Savings. Read table 5.2 of wattage and lumens of comparing 2 types of bulbs. (The information presented in this table is also in Table 1.2, but in a different format.) Read the table with students until they are comfortable using it.

Work through the example problems using dimensional analysis.

Allow students to calculate the missing information the tables (Questions 1-3) to compare costs of different bulbs. (Assume each bulb is used for the same number of hours each day.)

(30 min) Independent Practice

Skill Building: Lighting Assessment

Direct students to complete the energy use, cost table for 5 years of similar use among bulbs. Assume each bulb is used for the same number of hours each day.

Direct students to find the difference in expenditures for 1 year, 5 years.

(5 min) Conclusion: Direct students to write their findings, explaining how energy use and up-front/lifetime costs differed. Students should also answer this question: “Are there other ways to reduce energy besides switching light bulbs.”

Note to teacher:

LED lights are not covered in this lesson but could be a great research opportunity for students.
**Pros and Cons: CFLs vs. Incandescent**

**Mercury and Pollution**

While CFL light bulbs contain trace amounts of mercury, the US EPA notes that more energy is needed to light an incandescent bulb, creating five times more mercury from coal burning over the bulbs’ comparative lifetimes. The EPA estimates that a CFL uses up to 75% less energy than an incandescent bulb, while lasting up to 10 times longer.

**What should I do with a CFL when it burns out?**

EPA recommends that consumers take advantage of available local recycling options for compact fluorescent light bulbs. EPA is working with CFL manufacturers and major U.S. retailers to expand recycling and disposal options. Consumers can contact their local municipal solid waste agency directly, or go to [www.epa.gov/bulbrecycling](http://www.epa.gov/bulbrecycling) or [www.earth911.org](http://www.earth911.org) to identify local recycling options. If your state or local environmental regulatory agency permits you to put used or broken CFLs in the garbage, seal the bulb in two plastic bags and put it into the outside trash, or other protected outside location, for the next normal trash collection. Never send a fluorescent light bulb or any other mercury-containing product to an incinerator.

If your ENERGY STAR qualified CFL product burns out before it should, look at the CFL base to find the manufacturer’s name. Visit the manufacturer’s web site to find the customer service contact information to inquire about a refund or replacement. Manufacturers producing ENERGY STAR qualified CFLs are required to offer at least a two-year limited warranty (covering manufacturer defects) for CFLs used at home. In the future, save your receipts to document the date of purchase.

Source: US EPA. (June 2008.) Information on Compact Fluorescent Light Bulbs (CFLs) and mercury.

<table>
<thead>
<tr>
<th>Consideration</th>
<th>CFL</th>
<th>Incandescent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial cost</td>
<td>- $2-3 more up-front per bulb (but lasts much longer and will save money over time)</td>
<td>+</td>
</tr>
<tr>
<td>Energy use</td>
<td>+ up to 75% less than incandescent</td>
<td>-</td>
</tr>
<tr>
<td>Energy costs</td>
<td>+ up to 75% less than incandescent</td>
<td>-</td>
</tr>
<tr>
<td>Lifetime costs (initial + regularity of replacement)</td>
<td>+ fewer replacements and cheaper energy costs</td>
<td>-</td>
</tr>
<tr>
<td>Ease of disposal</td>
<td>- contains mercury</td>
<td>+</td>
</tr>
<tr>
<td>Safety of broken material</td>
<td>- contains mercury, see EPA disposal</td>
<td>+</td>
</tr>
<tr>
<td>Durability</td>
<td>+ lasts up to 10 times longer than an incandescent</td>
<td>-</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>? brighter per wattage</td>
<td>? many people are accustomed to incandescent; usually dimmer/softer light</td>
</tr>
<tr>
<td>Overall pollution</td>
<td>+ much less over its lifetime, including mercury</td>
<td>-</td>
</tr>
</tbody>
</table>
Types of Light bulbs

<table>
<thead>
<tr>
<th>Bare Products</th>
<th>Covered Products</th>
<th>Reflector Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini-Spiral or Twist</td>
<td>Tube or Universal</td>
<td>Incandescent/ A-line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Globe G25, G30, G40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Candelabra, Post or Bullet Shape</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indoor and Outdoor R20, R30, R40, PAR38</td>
</tr>
</tbody>
</table>


Note the tubular design of the compact fluorescent light bulbs

The United States Environmental Protection Agency offers a look at a variety of different Energy Star rated light bulbs, and where they might work for your home.

To see them, go to their page on compact fluorescent light bulbs and click on Choose a Light Guide. [http://www.energystar.gov/index.cfm?c=cfls.pr_cfls](http://www.energystar.gov/index.cfm?c=cfls.pr_cfls)

Model of an Incandescent Light Bulb

1. Outline of Glass bulb
2. Low pressure inert gas (argon, neon, nitrogen)
3. Tungsten filament
4. Contact wire (goes out of stem)
5. Contact wire (goes into stem)
6. Support wires
7. Stem (glass mount)
8. Contact wire (goes out of stem)
9. Cap (sleeve)
10. Insulation (vitrite)
11. Electrical contact

Source: Public Domain image, Wikimedia commons

Note the tungsten filament inside the incandescent light bulb. This is what heats up and produces the light.
Comparing Yearly Savings

Comparing savings of different lights used for 6 hours/day

Directions: Use Table 5.2 and your own calculations using dimensional analysis to fill in data tables.

Table 5.2  
Comparing Watts Used and Light Output of CFL and Incandescent Bulbs

<table>
<thead>
<tr>
<th>Wattage used by a CFL (EPA Average)</th>
<th>Lumens output</th>
<th>Wattage used by an incandescent (EPA Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 → 450</td>
<td>← 40</td>
<td></td>
</tr>
<tr>
<td>14 → 800</td>
<td>← 60</td>
<td></td>
</tr>
<tr>
<td>20 → 1,100</td>
<td>← 75</td>
<td></td>
</tr>
<tr>
<td>26 → 1,600</td>
<td>← 100</td>
<td></td>
</tr>
<tr>
<td>40 → 2,600</td>
<td>← 150</td>
<td></td>
</tr>
</tbody>
</table>


Example. For 450 Lumens

<table>
<thead>
<tr>
<th>Bulb Type</th>
<th>Power (W)</th>
<th>Energy use (kW)</th>
<th>Hours on per day (h/day)</th>
<th>kWh/day</th>
<th>E cost per kWh</th>
<th>Year cost (365 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td>10</td>
<td>0.01 kW</td>
<td>6 h/day</td>
<td>0.06 kWh/day</td>
<td>$0.10/kWh</td>
<td>$2.19/yr</td>
</tr>
<tr>
<td>Incandescent</td>
<td>40</td>
<td></td>
<td>6 h/day</td>
<td></td>
<td>$0.10/kWh</td>
<td>$8.76</td>
</tr>
</tbody>
</table>

Annual Cost Savings: **$8.76 – 2.19 = $6.57/yr**

450 Lumen CFL. Power (W) according to table is 10 W

1. To find energy use (kW):
   \[
   \frac{10 \text{ W}}{1,000 \text{ W}} = 0.01 \text{ kW}
   \]
2. To determine daily use (kWh/day):
   \[
   \frac{0.01 \text{ kW} \times 6 \text{ h/day}}{1 \text{ day}} = 0.06 \text{ kWh/day}
   \]
3. To find energy cost ($/day x 365 days/yr):
   \[
   \frac{0.06 \text{ kWh}}{1 \text{ day}} \times \frac{$0.10}{1 \text{ kWh}} \times 365 \text{ days/yr} = $2.19/\text{year}
   \]

450 Lumen Incandescent. Power (W) according to table is 40W

1. To find energy use (kW):
   \[
   \frac{40 \text{ W}}{1,000 \text{ W}} = 0.04 \text{ kW}
   \]
2. To determine daily use (kWh/day):
   \[
   \frac{0.04 \text{ kW} \times 6 \text{ h/day}}{1 \text{ day}} = 0.24 \text{ kWh/day}
   \]
3. To find energy cost ($/day x 365 days/yr):
   \[
   \frac{0.24 \text{ kWh}}{1 \text{ day}} \times \frac{$0.10}{1 \text{ kWh}} \times 365 \text{ days/yr} = $8.76/\text{year}
   \]
### Skill Building

#### 1. Find the annual cost savings for 800 Lumens light bulbs

<table>
<thead>
<tr>
<th>Bulb Type</th>
<th>Power (W)</th>
<th>Energy use (kW)</th>
<th>Hours on per day (h/day)</th>
<th>Daily kWh</th>
<th>E cost</th>
<th>Year cost (365 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incandescent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Annual Cost Savings:

Step 1 \[
\frac{\text{__ W}}{1,000 \text{ W}} = \]

Step 2 \[
\frac{\text{__ kW}}{6 \text{ h/day}} = \]

Step 3 \[
\frac{\text{__ kWh}}{1 \text{ day}} \times \frac{\$0.10}{1 \text{ kWh}} \times \frac{365 \text{ days}}{1 \text{ year}} = \]

#### 2. Find the annual cost savings for 1,100 Lumens

<table>
<thead>
<tr>
<th>Bulb Type</th>
<th>Power (W)</th>
<th>Energy use (kW)</th>
<th>Hours on per day (h/day)</th>
<th>Daily kWh</th>
<th>E cost</th>
<th>Year cost (365 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incandescent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Annual Cost Savings:

Step 1 \[
\frac{\text{__ W}}{1,000 \text{ W}} = \]

Step 2 \[
\frac{\text{__ kW}}{6 \text{ h/day}} = \]

Step 3 \[
\frac{\text{__ kWh}}{1 \text{ day}} \times \frac{\$0.10}{1 \text{ kWh}} \times \frac{365 \text{ days}}{1 \text{ year}} = \]

#### 3. Find the annual cost savings for 1,600 Lumens

<table>
<thead>
<tr>
<th>Bulb Type</th>
<th>Power (W)</th>
<th>Energy use (kW)</th>
<th>Hours on per day (h/day)</th>
<th>Daily kWh</th>
<th>E cost</th>
<th>Year cost (365 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incandescent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Annual Cost Savings:

Step 1 \[
\frac{\text{__ W}}{1,000 \text{ W}} = \]

Step 2 \[
\frac{\text{__ kW}}{6 \text{ h/day}} = \]

Step 3 \[
\frac{\text{__ kWh}}{1 \text{ day}} \times \frac{\$0.10}{1 \text{ kWh}} \times \frac{365 \text{ days}}{1 \text{ year}} = \]

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The Home Environment | Lesson 4

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Name ___________________________
Lighting Assessment

Remember: Show your work and make sure you use the correct label on all your answers!

Directions: Use your calculations from Comparing Yearly Savings to answer the following questions

Example. Imagine you switched five 450-Lumen incandescent bulbs for five 450-Lumen CFL bulbs. How much money would you save on electricity?

1. Check how much your annual savings are for 1 bulb.
2. If you save $6.57 for each 450-Lumen bulb switch, multiply the savings by the amount of bulbs you switched.
3. $6.57/yr \times 5 = $32.85/yr

1. How much money would you save over the year if you switched three 800-Lumen incandescent bulbs for three 800 Lumen CFL bulbs?

2. How much money would you save annually if you traded four 1,100-Lumen incandescent bulbs for four 1,100-Lumen CFL bulbs?

3. CHALLENGE: Look at Table 5.2 About how many 2,600-Lumen CFL bulbs could you run to equal the energy use of one 2,600-Lumen incandescent bulb.
<table>
<thead>
<tr>
<th>OUTDOOR PROJECTED</th>
<th>OUTDOOR HARCASER</th>
<th>CANDLE</th>
<th>TUBED</th>
<th>GLOBE</th>
<th>DIMMABLE ACHIES</th>
<th>SPIRAL</th>
</tr>
</thead>
</table>

**AVOID EARLY BURN OUT:**
- Most photo cells and timers are not designed to work with CFLs.

**HOW TO CHOOSE THE RIGHT ENERGY STAR QUALIFIED LIGHT BULB**


**LEARN MORE AT energy.gov**
Handling Broken CFL Bulbs
Source: US EPA. (June 2008.) Information on Compact Fluorescent Light Bulbs (CFLs) and mercury.

How should I clean up a broken fluorescent bulb?
Because CFLs contain a small amount of mercury, EPA recommends the following clean-up and disposal guidelines:

1. Before Clean-up: Air Out the Room
   • Have people and pets leave the room, and don’t let anyone walk through the breakage area on their way out.
   • Open a window and leave the room for 15 minutes or more.
   • Shut off the central forced-air heating/air conditioning system, if you have one.

2. Clean-Up Steps for Hard Surfaces
   • Carefully scoop up glass fragments and powder using stiff paper or cardboard and place them in a glass jar with metal lid (such as a canning jar) or in a sealed plastic bag.
   • Use sticky tape, such as duct tape, to pick up any remaining small glass pieces and powder.
   • Wipe the area clean with damp paper towels or disposable wet wipes. Place towels in the glass jar or plastic bag.
   • Do not use a vacuum or broom to clean up the broken bulb on hard surfaces.

3. Clean-up Steps for Carpeting or Rug:
   • Carefully pick up glass fragments and place them in a glass jar with metal lid (such as a canning jar) or in a sealed plastic bag.
   • Use sticky tape, such as duct tape, to pick up any remaining small glass fragments and powder.
   • If vacuuming is needed after all visible materials are removed, vacuum the area where the bulb was broken.
   • Remove the vacuum bag (or empty and wipe the canister), and put the bag or vacuum debris in a sealed plastic bag.

4. Clean-up Steps for Clothing, Bedding, etc.:
   • If clothing or bedding materials come in direct contact with broken glass or mercury-containing powder from inside the bulb that may stick to the fabric, the clothing or bedding should be thrown away. Do not wash such clothing or bedding because mercury fragments in the clothing may contaminate the machine and/or pollute sewage.
   • You can, however, wash clothing or other materials that have been exposed to the mercury vapor from a broken CFL, such as the clothing you are wearing when you cleaned up the broken CFL, as long as that clothing has not come into direct contact with the materials from the broken bulb.
   • If shoes come into direct contact with broken glass or mercury-containing powder from the bulb, wipe them off with damp paper towels or disposable wet wipes. Place the towels or wipes in a glass jar or plastic bag for disposal.

5. Disposal of Clean-up Materials
   • Immediately place all clean-up materials outdoors in a trash container or protected area for the next normal trash pickup.
   • Wash your hands after disposing of the jars or plastic bags containing clean-up materials.
   • Check with your local or state government about disposal requirements in your specific area. Some states do not allow such trash disposal. Instead, they require that broken and unbroken mercury-containing bulbs be taken to a local recycling center.

6. Future Cleaning of Carpeting or Rug: Air Out the Room During and After Vacuuming
   • The next several times you vacuum, shut off the central forced-air heating/air conditioning system and open a window before vacuuming.
   • Keep the central heating/air conditioning system shut off and the window open for at least 15 minutes after vacuuming is completed.

What is mercury?
Mercury is an element (Hg on the periodic table) found naturally in the environment. Mercury emissions in the air can come from both natural and man-made sources. Coal-fired power plants are the largest man-made source because mercury that naturally exists in coal is released into the air when coal is burned to make electricity. Coal fired power generation accounts for roughly 40 percent of the mercury emissions in the U.S. The use of CFLs reduces power demand, which helps reduce mercury emissions from power plants. For more information on all sources of mercury, visit http://www.epa.gov/mercury

For more information about compact fluorescent bulbs, visit http://www.energystar.gov/cfls
Learning Objectives
1. Students will identify sources of waste in their daily lives.
2. Students will create a new product from waste materials.
3. Students will account for their waste, by type and volume.
4. Students will brainstorm ways to reduce waste.

Materials
- Poster to ID sources of waste
- Clean garbage (Paper, Plastic, Wood, Clothing, Shoes, Containers)
- Table of Values: Trash by type in USA
- Adhesive supplies as applicable (glue, tape, staples, hammer and nails)
- Art supplies (paint, brushes, markers)
- List of possible products for students to choose from/add to list: Yard art, Planter, Bird house, Toys, Paper weight, Materials container

Possible Group Roles
1. Leader: in charge of keeping group focused
2. Secretary: takes notes about the group’s ideas for the project
3. Illustrator: creates initial illustration of item
4. Spokesperson: Tells class about the group's work
5. Materials gatherer: collects materials from the teacher to use for the project
6. Questioner: asks questions to elicit sharing of ideas, concerns
7. Peacemaker: tries to find compromise/build consensus among opposing viewpoints

Hour 1
(5 min) Setting the Stage: Hold up a bunch of clean trash. Ask students what happens to this once it is thrown in the garbage. Ask what else could be done with this trash. Could a new product be formed from any of it?

Part I
As a whole group, brainstorm a list of trash. Ask students to identify items that could be reused/handled safely without threat of spreading germs, causing bodily harm, and circle those items on the list.

Assign small groups. Distribute items of clean trash to students (you can either choose the items for the students, or allow them to choose their own items as a group).

Students should have time to handle the items before deciding on a design.

Ask students to present a drawing of what they intend to make as well as a list of things they may need to make it (art supplies, adhesives, etc.). Collect the drawings.

Conclude the first lesson by asking students how they decided on an item. What was the hardest part of the decision making process?

Hour 2

Part II
Distribute table of values showing landfill weight by type.

Group Practice: Direct students to calculate different amounts of landfill mass that could be saved if...
1. all paper were recycled
2. all wood were reused
3. half of all metal were recycled

Show drawings to class from previous day. Tell them they will begin working on construction today.

Distribute materials for groups to work on construction.

Make available art and adhesive supplies.

Conclude the second lesson by checking in with all groups. Class discussion on what has been difficult, easy and what might make the third day go well.

Hour 3

Part III
Have a spokesperson from each group briefly remind the class what the group is working on and how they plan to finish today.

Assessment: Students should write a full paragraph answer to each of these questions: How reasonable is it for individuals to make our garbage into new, useful products? What would be two better environmental solutions?

Students share projects and teacher can display them in the classroom or school setting.
**Table 5.1**

*Trash by type in USA*


<table>
<thead>
<tr>
<th>Type of garbage</th>
<th>Thousands of tons in waste stream</th>
<th>Percent of Total Waste, by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>85,290</td>
<td>34.9</td>
</tr>
<tr>
<td>Glass</td>
<td>13,200</td>
<td>5.3</td>
</tr>
<tr>
<td>Metals</td>
<td>14,220</td>
<td>5.7</td>
</tr>
<tr>
<td>Plastics</td>
<td>29,490</td>
<td>11.7</td>
</tr>
<tr>
<td>Rubber and leather</td>
<td>6,540</td>
<td>2.6</td>
</tr>
<tr>
<td>Textiles</td>
<td>11,840</td>
<td>4.7</td>
</tr>
<tr>
<td>Wood</td>
<td>13,930</td>
<td>5.5</td>
</tr>
<tr>
<td>Food Scraps</td>
<td>12,200</td>
<td>5.0</td>
</tr>
<tr>
<td>Yard Trimings</td>
<td>20,000</td>
<td>8.2</td>
</tr>
<tr>
<td>Other</td>
<td>38,000</td>
<td>15.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>244,710</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Thousands of tons in waste stream, 2006**

![Pie chart showing the distribution of trash by type in 2006](chart1.png)

**Percentage of garbage, by type in waste stream, 2006**

![Pie chart showing the percentage distribution of trash by type in 2006](chart2.png)
Learning Objectives

1. Students will demonstrate proficiency in testing appliances for amount of power drawn while operating and “sleeping”.
2. AND/OR students will calculate the total energy usage over given periods of time for familiar household items.

Materials

- Kill-A-Watt* energy meter and several examples of household appliances
  *If Kill-A-Watt is not available for use, this lesson may serve as a good review of the skills learned in Lesson 1: Energy Use. Or, use a Watts Up! Meter. These may be available for loan from KEEP (see Appendix) or Focus on Energy
- AND/OR
  Skill Building: Table 6.1
- Current average costs of energy (kWh, according to local utility companies—you can find this on an energy bill)
- Skill Building: Measuring Loads

Hour 1

(5 min) Setting the Stage: Hold up the Kill-A-Watt. Ask students what they think it does. Explain to them that it measures the amount of energy used by appliances.

OR

Turn a digital appliance (e.g., TV, Radio, Computer) on and off. Ask students in which state, on or off, does it use no energy. It’s a trick question—it is always using energy as long as it is plugged in.

(20 min) Presentation: Explain to students that they will be determining the energy use (wattage) of common appliances.

Review the term phantom load. It is the amount of energy used while an appliance is turned off. Often an appliance requires the phantom load to maintain a certain temperature, to keep a memory, or to maintain a readiness to be turned on quickly. Often, these appliances that drain energy while not in use are referred to as vampires.

Ask students why specific appliances may need to draw energy at all times. Some examples you can discuss include refrigerator, digital radio, DVD player.

Discussion: Ask students if certain appliances can be turned off and unplugged while not in use. For example, computer printers, televisions. What would be the problems associated with unplugging and re-plugging?

(15 min) Group Practice:

If using Kill-A-Watt:

Distribute or have students create empty data tables. Across the top should be energy use while running, energy use while off. Along the side should be names of appliances. Use Table 6.1 as an example.

Allow students to test various appliances with Kill-A-Watt. They should record energy use in a data table.

If not using Kill-A-Watt:

Using a recent energy bill, determine the average cost per kilowatt hour. A kilowatt hour is the amount of energy it takes to run a 1 kilowatt appliance for an hour.

Skill Building: Table 6.1. (This table is similar to one used in an earlier lesson—one column has been removed.)

Explain that many appliances fall short of 1kW. For example, a light bulb might use 100 watts. Over the course of an hour, the energy use of that bulb would be 100Wh. And so, it would take 10 hours to be charged the standard rate for the kWh on your energy bill.
Skill Building

To calculate the cost per hour of your appliance, you would need to convert to similar units first. It is easy to convert kWh into Wh. All you have to do is multiply 1000 Wh/kWh • 1 kWh = 1000 Wh. Your price for 1 kWh would equal your price for 1000 Wh.

\[
\frac{1000 \text{ Wh}}{1 \text{ kWh}} = 1000 \text{ Wh}
\]

If you have the price per 1000 Wh, for example $0.10/1000Wh, you can easily multiply to cancel out and find your cost for running an appliance for an hour.

If your light bulb uses 100W, and you’d like to calculate how much it costs to use that bulb for an hour, your formula would be Price/1,000Wh × Wattage of the bulb. In our example, it would be $0.10/1,000Wh × 100W = $0.01/h. Not very expensive. But, when you compound that over time, the costs add up.

\[
\frac{\$0.10}{1000 \text{ Wh}} \times 100 \text{ W} = \$0.01/h
\]

Let’s say that energy costs are half as much, at $0.05. Recalculate your costs for using the bulb for an hour.

\[
\frac{\$0.05}{1000 \text{ Wh}} \times 100 \text{ W} = \$0.005/h
\]

How long would it take to cost 1 cent? How long would it take to cost $1.00? What would happen if you were running multiple lights at the same time (eg. 2, 3, 10).

Continue group practice as needed. Measure costs of different appliances to practice dimensional analysis.

(20 min) Independent Practice.

Skill Building: Measuring Loads

Note: The total of third and fourth column should add to 24 hours, assuming appliance is plugged in all day.

Students will calculate total daily energy use, either in kWh or in Wh of selected appliances. If one appliance (eg. lamp and light bulb) is only one of many of those types, students should multiply energy use by how many of those appliances are used.

Assessment: Using a standard cost for kWh, or 1000 Wh, students should calculate an estimate of how much energy is used inside their classroom and inside a selected/hypothetical room in their home.

Lesson Extension

As a whole group, create two hypothetical homes and calculate the difference between a hypothetical efficient home and hypothetical inefficient home.

Additional Possibilities

1. The KEEP curriculum (K-12 Energy Education Program) would fit in nicely here. (See appendix.)
### Table 6.1

**Appliances and their idle and active wattage**

<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>Standby [Idle] (W)</th>
<th>Active (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>Desktop</td>
<td>4.4</td>
<td>69.7</td>
</tr>
<tr>
<td></td>
<td>Laptop</td>
<td>1.0</td>
<td>21.9</td>
</tr>
<tr>
<td>Computer Monitor</td>
<td>CRT</td>
<td>1.8</td>
<td>70.3</td>
</tr>
<tr>
<td></td>
<td>LCD</td>
<td>1.1</td>
<td>27.0</td>
</tr>
<tr>
<td>Printer</td>
<td>Inkjet</td>
<td>1.7</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>Laser</td>
<td>1.3</td>
<td>39.0</td>
</tr>
<tr>
<td>Scanner</td>
<td>Flatbed</td>
<td>5.7</td>
<td>12.2</td>
</tr>
<tr>
<td>Hub</td>
<td>USB</td>
<td>1.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Modem</td>
<td>Cable</td>
<td>4.5</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>DSL</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Router</td>
<td>Wireless</td>
<td>1.7</td>
<td>6.2</td>
</tr>
<tr>
<td>Speakers</td>
<td>Computer</td>
<td>2.6</td>
<td>7.2</td>
</tr>
<tr>
<td>Television</td>
<td>CRT</td>
<td>3.2</td>
<td>73.0</td>
</tr>
<tr>
<td></td>
<td>LCD</td>
<td>2.2</td>
<td>69.9</td>
</tr>
<tr>
<td></td>
<td>Plasma</td>
<td>0.9</td>
<td>245.9</td>
</tr>
<tr>
<td>Television/DVD</td>
<td></td>
<td>3.0</td>
<td>36.5</td>
</tr>
<tr>
<td>Television/DVD/VCR</td>
<td></td>
<td>2.5</td>
<td>65.0</td>
</tr>
<tr>
<td>Television/VCR</td>
<td></td>
<td>3.7</td>
<td>54.8</td>
</tr>
<tr>
<td>Cable/Satellite Box</td>
<td>Analog cable*</td>
<td>10.2</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>Digital cable*</td>
<td>26.4</td>
<td>26.4</td>
</tr>
<tr>
<td></td>
<td>Digital cable with DVR*</td>
<td>43.0</td>
<td>43.0</td>
</tr>
<tr>
<td></td>
<td>DVR*</td>
<td>36.7</td>
<td>36.7</td>
</tr>
<tr>
<td></td>
<td>Satellite</td>
<td>12.3</td>
<td>16.0</td>
</tr>
<tr>
<td></td>
<td>Satellite with DVR</td>
<td>24.8</td>
<td>33.6</td>
</tr>
<tr>
<td>VCR</td>
<td></td>
<td>2.4</td>
<td>13.2</td>
</tr>
<tr>
<td>DVD Player</td>
<td></td>
<td>1.0</td>
<td>10.8</td>
</tr>
<tr>
<td>Game Console</td>
<td></td>
<td>1.0</td>
<td>24.2</td>
</tr>
<tr>
<td>CD Player</td>
<td></td>
<td>1.3</td>
<td>6.7</td>
</tr>
<tr>
<td>CD Recorder</td>
<td></td>
<td>0.0</td>
<td>11.7</td>
</tr>
<tr>
<td>Radio</td>
<td></td>
<td>1.5</td>
<td>11.6</td>
</tr>
<tr>
<td>Portable Stereo</td>
<td></td>
<td>1.6</td>
<td>8.2</td>
</tr>
<tr>
<td>Garage Door Opener</td>
<td></td>
<td>4.8</td>
<td>108.0</td>
</tr>
<tr>
<td>Water Dispenser</td>
<td></td>
<td>100.2</td>
<td>628.0</td>
</tr>
<tr>
<td>Coffee Maker</td>
<td></td>
<td>1.5</td>
<td>182.5</td>
</tr>
<tr>
<td>Clock</td>
<td>With Radio</td>
<td>5.4</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td>Without Radio</td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>Chargers</td>
<td>CD Player</td>
<td>0.8</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>Cell Phone</td>
<td>0.2</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>Digital Music Player*</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>Still Camera</td>
<td>0.3</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Portable TV/Video Camera</td>
<td>0.0</td>
<td>0.05</td>
</tr>
</tbody>
</table>

For calculations, use $0.10/kWh as the cost for electricity.
# Measuring Loads

Measuring costs of in-use loads and phantom loads

Directions: Use dimensional analysis to convert units and determine money spent on in-use and phantom loads per month. Then find the cost per year. Write your answers in the tables provided. Use $0.10 as the cost per kWh.

To calculate monthly cost, follow this formula:

\[
\text{To calculate monthly cost, follow this formula:} \\
\text{Remember to cancel units and multiply across!} \\
\frac{\_ \text{W}}{1 \text{kW}} \times \frac{\_ \text{h}}{1 \text{ day}} \times \frac{\$\_}{1 \text{kWh}} \times \frac{30 \text{ days}}{1 \text{ month}} = \$\_ \text{ month}
\]

**Example.** Calculate the monthly bill for a plasma screen TV that is on 5 hours/day. Remember: the time in-use and the time idle should add to 24 hours (we will assume that there is no time spent in low power use)

1. Determine in-use cost:

\[
\frac{245.9 \text{ W}}{1 \text{kW}} \times \frac{5 \text{ h}}{1 \text{ day}} \times \frac{\$0.10}{1 \text{kWh}} \times \frac{30 \text{ days}}{1 \text{ month}} = \$3.69 \text{ month}
\]

2. Determine phantom load cost:

\[
\frac{0.9 \text{ W}}{1 \text{kW}} \times \frac{19 \text{ h}}{1 \text{ day}} \times \frac{\$0.10}{1 \text{kWh}} \times \frac{30 \text{ days}}{1 \text{ month}} = \$0.05 \text{ month}
\]

3. Find the sum of in-use and phantom load: $3.69 + 0.05 = $3.72/mo

4. Find the cost per year by multiplying the monthly sum by 12 months in a year: $3.72 x 12 = $44.64

1. Determine the monthly and annual costs of using a laser printer for 10 minutes/day, or 0.17h/day. It’s phantom load time would be 23h50m (minutes) or 23.83h/day.

<table>
<thead>
<tr>
<th>Cost for in-use load/month:</th>
<th>_ \text{W}</th>
<th>1 \text{kW}</th>
<th>_ \text{h}</th>
<th>$_</th>
<th>30 \text{ days}</th>
<th>= $_ \text{ month}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost for phantom load/month:</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Sum of loads:</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Cost for annual load:</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------</td>
<td>------------------</td>
</tr>
</tbody>
</table>

2. Determine the monthly and annual costs for the use of an electric garage door for 3 minutes a day (0.05h/day) in-use and 23h57m/day (23.95h/day) phantom load.

<table>
<thead>
<tr>
<th>Cost for in-use load/month:</th>
<th>_ \text{W}</th>
<th>1 \text{kW}</th>
<th>_ \text{h}</th>
<th>$_</th>
<th>1 \text{ month}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost for phantom load/month:</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td>Sum of loads:</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td>Cost for annual load:</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------</td>
</tr>
</tbody>
</table>

3. **CHALLENGE:** Determine the monthly and annual costs for operating a cable box with DVR. Its in-use and phantom loads are taken to be the same. This should take fewer calculations than the previous problem. Find cost of total monthly load and cost for annual load.

<table>
<thead>
<tr>
<th>Cost for in-use load/month:</th>
<th>_ \text{W}</th>
<th>1 \text{kW}</th>
<th>_ \text{h}</th>
<th>$_</th>
<th>30 \text{ days}</th>
<th>= $_ \text{ month}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost for phantom load/month:</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Sum of loads:</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Cost for annual load:</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------</td>
<td>------------------</td>
</tr>
</tbody>
</table>
Learning Objectives

1. Students will describe alternative sources for construction materials.
2. Students will estimate environmental and financial costs and benefits of several types of materials.

Materials

- Examples of different building materials, sheet or teacher-provided visuals
- **Skill Building**: Examples of Different Building Materials
- **Skill Building**: Green Building Materials
- **Skill Building**: Calculating FSC-Certified Wood Costs
- **Skill Building**: Sustainable Wood Suppliers in Wisconsin

Preparation

- Make a transparency of the image of a railroad tie

Hour 1

**(5 min)** Setting the Stage: Display visual of railroad tie. Ask students what they think it is. Explain.

Ask students what might be done with it if a railroad is torn up or if the tie must be replaced. Guide toward an answer that reflects its possibility for reuse as a building material.

**(20 min)** Presentation: Brainstorm a list of supplies that went into creating student homes. Use the school/classroom as a springboard for ideas if students get stuck.

Share with students the information from **Skill Building**: Examples of Different Building Materials, either by giving them a copy, projecting it on an overhead, or writing the list on the board.

Ask students if anything on the list surprised them.

**Skill Building**: Green Building Materials. Read and discuss as a class.

Share with students the information from **Skill Building**: Sustainable Wood Suppliers in Wisconsin, either by giving them a copy, projecting it on an overhead, or writing the list on the board.

Discuss the idea of “values.” Why might someone purchase more environmentally friendly materials, even if it costs more? What might prevent someone from purchasing sustainable materials?

**Skill Building**: Calculating FSC-Certified Wood Costs

As a whole group, discuss the example problem.

**(20 min)** Independent Practice: Students will calculate the rest of the costs of FSC wood on the worksheet.

**(10 min)** Conclusion: Discussion question (oral or written): What keeps people from using sustainable building supplies? What could be done to make these supplies more appealing to the consumer?

Lesson Extension:

Have students research one of these alternative building materials: cob, straw bale, adobe, stucco, SIPs, or urbanite. What are these materials? Why are they considered environmentally friendly? Can you get a permit to these materials in your town?
### Examples of Different Building Materials

<table>
<thead>
<tr>
<th></th>
<th>Foundation</th>
<th>Inside Walls</th>
<th>Outside Walls</th>
<th>Windows</th>
<th>Siding</th>
<th>Piping</th>
<th>Roofing</th>
<th>Waterproofing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Concrete</td>
<td>Concrete</td>
<td>Stone</td>
<td>Glass, with varying R-Values</td>
<td>Vinyl</td>
<td>Plastic</td>
<td>Slate</td>
<td>Tar</td>
</tr>
<tr>
<td></td>
<td>Treated wood</td>
<td></td>
<td>Brick</td>
<td>(or U-Values, the inverse of</td>
<td>Aluminum</td>
<td>PVC</td>
<td>Asphalt, fiberglass</td>
<td>Rubber</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R-Values)</td>
<td>Wood</td>
<td>High-density polyethylene</td>
<td>and gravel</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>composite</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tiles (ceramic, stone,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>or glass)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Suppliers:**

Nationwide:


In the Upper Midwest:

2. Natural Built Home (Minnesota) [http://www.naturalbuilthome.com/](http://www.naturalbuilthome.com/)


Green Building Materials

Environmentally friendly, or “green”, building is building that takes into account the environmental impacts of construction, and aims to construct in a sustainable way. The United States Environmental Protection Agency has been promoting green building for many years. The EPA claims that ecologically sound construction projects can enhance biodiversity, reduce operating costs, and enhance health and quality of life.

Several components of construction must be taken into account. Energy efficiency, water use, waste creation and reduction, toxins in materials, sustainable materials, and indoor air quality are major pieces in the green-building puzzle. Also considered in many projects is green landscaping, although this lesson does not go into that particular topic.

People who are building a new home have many options for material sources and construction design. To assist these people in making decisions, the EPA’s provides a web page entitled Components of Green Building, which can be found at http://www.epa.gov/greenbuilding/pubs/components.htm.

Probably the two most common resources used by home builders are cement and wood. Cement comes from crushed, cooked limestone. The process of preparing cement has been calculated to produce 5% of the entire global greenhouse gas emissions! Cement makers around the world are trying to figure out ways to use less energy when making large quantities of cement, thus decreasing their costs and emissions. Companies in the US have only recently begun producing more environmentally-friendly cement. Wood can come from trees or bamboo (a tall, strong grass species) in tropical forests, temperate forests, and recycled material such as old railroad ties. The Forest Stewardship Council is the world’s number one certifier of sustainably harvested wood. Many options for FSC certified wood exist in the US. Also of interest is formaldehyde-free wood, as formaldehyde can cause irritation and may be carcinogenic (cancer-causing).

Resources


Wisconsin Themed:


Sources:
Calculating FSC-Certified Wood Costs

To acquire FSC-Certified and formaldehyde-free wood, one can expect to pay a premium of 0.5%-2.5%, according to 9Wood, a lumber wholesaler in Oregon.

Example. Let’s say that you could spend $100 on “normal” wood. How much could you expect to pay for the same amount of wood if it is FSC-Certified and/or formaldehyde free?

First calculate the low estimate (normal + 0.5% of normal)

$100 + 0.005($100) = $100 + $0.50 = $100.50

Next find the mid range estimate (normal + 1.5% of normal)

$100 + 0.015($100) = $100 + $1.50 = $101.50

Last, find the high estimate of FSC wood (normal + 2.5% of normal)

$100 + 0.025($100) = $100 + $2.50 = $102.50

1. Complete the table. Base your answers on the normal cost.

<table>
<thead>
<tr>
<th>“Normal” wood cost</th>
<th>Low estimate FSC cost (“normal” + 0.5%)</th>
<th>Mid-range estimate FSC cost (“normal” + 1.5%)</th>
<th>High estimate FSC cost (“normal” + 2.5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$100</td>
<td>$100.50</td>
<td>$101.50</td>
<td>$102.50</td>
</tr>
<tr>
<td>$1,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$20,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$50,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$100,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Show calculations here or on another sheet.

Bonus. Do you see a way to calculate each answer in this chart using only one step of multiplication (instead of multiplication and addition)?
Sustainable Wood Suppliers in Wisconsin

All companies listed carry Forest Stewardship Council certified wood.

- **Boehm-Madisen Lumber Co., Inc.**
  www.boehmmadisen.com
  800.242.2069

- **Stock Building Supply**
  www.stockbuildingsupply.com
  920.337.1660, ext. 230

- **Central Wisconsin Woodworking Corporation**
  715.675.4491

- **Fiberesin Industries, Inc.**
  www.fiberesin.com
  262.567.4427

- **Cecco Trading Inc**
  www.ironwoods.com
  414.445.8989

- **Algoma Hardwoods**
  www.algomahardwoods.com
  920.487.5221 - 800.678.8910

- **Eggers Industries, Inc.**
  www.eggersindustries.com
  920.793.1351 or 920.722.6444

- **H Window Company, LLC**
  www.hwindow.com
  715.685.2793

- **Marshfield Door Systems, Inc.**
  www.marshfielddoors.com
  715.486.2363

- **Oshkosh Architectural Door Company**
  www.oshkoshdoor.com
  920.233.6161

- **Birds Eye Veneer Company**
  715.769.3912

- **Aacer Flooring**
  www.aacerflooring.com
  817.582.1181 - 715.582.1181

- **Action Floor Systems, LLC**
  www.actionfloors.com
  715.476.3512 - 800.746.3512

- **Robbins, Inc.**
  www.robbinsfloor.com
  715.882.2011

- **Rodman Industries, Inc.**
  www.resincore1.com
  262.569.5820

- **Colonial Craft**
  www.colonialcraft.com
  800.289.6653

- **Woodland Face Veneer LLC**
  920.553.9663

Railroad Tie
Learning Objectives

1. Students will accurately describe several sources of these materials, discuss environmental costs and benefits of the use of different types, factoring in durability, recyclability, source, and initial costs, and calculate economic costs for purchases based on differing values.

Materials

- Room images (from magazines) or samples of different flooring materials. (Flooring stores will often have samples that you can have or borrow.)
- **Skill Building: Carpet and Furniture Choices**
- Table of initial costs and average lifespan (based on warranty) of materials
- **Skill Building: Furnishing Plan**
- **Skill Building: Extension: Is your home a health hazard? (if needed)**

**Hour 1***

(5 min) Setting the Stage: Display visuals of various flooring options. Ask why each may have been chosen for that particular room. Write a list of reasons people choose the carpeting they do (aesthetics, price, durability) on the white board.

(15 min) Presentation: Explain that when adults furnish a home, they often do so using a variety of values.

*Short Term Economics* is a value — people often purchase carpeting and furniture based on affordability.

*Long Term Economics* is a value — people can purchase items based on how well they are made and how long they will last.

*Aesthetics* is a value — people purchase items based on how they look, how they match other items.

*Environmental responsibility* is a value — some people choose to purchase items based on how sustainably they were produced, and how long they will last before needing replacement.

Discussion questions: Can these values ever come into conflict? Can some/most of these values ever match up?

(10 min) Group Practice:

- **Skill Building: Carpet and Furniture Choices.** Read as a group. Ask students what values are alluded to in the article.
- **Skill Building: Initial Costs of Flooring and Furniture Options.** Discuss this table of hypothetical initial costs and average lifespan (based on warranty) of materials.

Tell students they are going to create furnishing plans based on the different values discussed, except for aesthetics, as we are assuming that any product can be made to match aesthetic needs of the customer.

There should be a plan for short-term economics, long-term economics, and environmental values.

(20 min) Individual Practice:

- **Skill Building: Furnishing Plan.** Students should determine a sum for each plan for up-front costs and costs over lifetime (can be calculated anywhere from 10-50 years, factoring in the need to purchase new items, if applicable).

(5 min) Conclusion: If something costs more up-front, and does not outlast materials that are cheaper, is it worthwhile to the consumer to purchase the item? What could be done to make it more worthwhile?

Lesson Extension:

Read the article *Is your home a health hazard?*

*This lesson can be extended into two class periods, depending on depth of discussion and detail in furnishing plans.*
Carpet and Furniture Choices

Carpet

Many considerations go into the purchasing of new carpet. Does it look nice? Will it hold up against the amount of foot traffic in the house/building? Will it be easy to clean? How much does it cost? But, to many people, another consideration is just as important as these practical ones. Was it produced in a sustainable manner, and is it healthy for people and the environment?

“Green carpeting” earns its name by meeting certain standards. It is produced in a way that does not cause (much) harm to the environment. It may be made out of recycled material. It could be made out of natural fibers instead of petroleum-based fibers like the commonly used “nylon 6” or “nylon 6,6.”

Green carpeting should be durable. It should stand up to the amount of foot traffic that regularly travels over it. The longer it lasts, the less often it will have to be replaced.

Green carpeting should be safe and healthy to breathe around. The glue used in many carpets emits substances called volatile organic compounds (VOCs). VOCs are substances that can destroy the ozone layer, can contribute to smog, and can cause people to develop a disease called Multiple Chemical Sensitivity (MCS). MCS makes people highly reactive to chemicals that we encounter on a daily basis. Other symptoms can include fatigue, memory loss, and sleeping problems.

Given the environmental and health risks of traditional carpeting, many companies are offering green options. To see what options exist in your area, visit the National Green Pages at: [http://www.coopamerica.org/pubs/greenpages](http://www.coopamerica.org/pubs/greenpages). If you can’t find anything in your home state, check the states that border yours.

Furniture

The average American spends 90% of his or her life indoors. We watch TV, read books, use computers, play video games, eat and sleep indoors. To do all this, we need furniture. People enjoy furniture that is comfortable, attractive and long lasting. Many people also want furniture that is manufactured sustainably and is healthy to be around.

Sustainable furniture means different things to different people. Generally, to be considered “green”, wood for furniture should come from a forest that is managed in an ecologically sound way. Or, like some metals and plastics available for furniture, it can come from recycled products. Or, it can be made from fast-growing bamboo.

Fabric for furniture can also come from recycled products, or be made out of natural materials like hemp, flax, cotton or wool that are grown or raised in an environmentally friendly manner.

Most furniture is treated with chemicals. These could be to stain/finish the wood, help parts stick together, or dye material. There are many green replacements for chemicals traditionally used by manufacturers. These products help reduce indoor volatile organic compounds.

To see what options exist, visit the Green Pages, and do a furniture search for your state, bordering states or “anywhere.” Many businesses around the country will ship to your home location. [http://www.coopamerica.org/pubs/greenpages](http://www.coopamerica.org/pubs/greenpages)

Sources:


MultipleChemicalSensitivity.org. What is Multiple Chemical Sensitivity (MCS)? [http://www.multiplechemicalsensitivity.org/](http://www.multiplechemicalsensitivity.org/)


Initial Costs of Flooring and Furniture Options

Calculating a square yard:

- A square foot is 1 foot × 1 foot
- 3 feet make one yard
- So, a square yard is
  3 feet × 3 feet = 9 square feet

Interesting Carpet Notes

- Cheap home carpet typically cost between $5.00 and $20.00 per square yard.
- Mid-range carpets cost from $20.00-$30.00 per square yard.
- High-range, decorative carpets can cost around $45.00 per square yard.
- Mid-range and high-range carpeting typically lasts 12-15 years before showing signs of wear.

Table 9.3a Flooring Options

<table>
<thead>
<tr>
<th>Brand</th>
<th>Name</th>
<th>Type of flooring</th>
<th>Cost per area ($/sq yd)</th>
<th>Typical Retailer Warranty</th>
<th>“Green”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaulieu of America</td>
<td>Sand Dollar</td>
<td>Nylon</td>
<td>$11.88</td>
<td>10 years</td>
<td>No</td>
</tr>
<tr>
<td>Anatole</td>
<td>Nylon</td>
<td>$8.91</td>
<td>10 years</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Thoroughbred</td>
<td>Nylon</td>
<td>$8.91</td>
<td>10 years</td>
<td>No</td>
<td></td>
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<tr>
<td>Perfection</td>
<td>Nylon</td>
<td>$4.23</td>
<td>5 years</td>
<td>No</td>
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</tr>
<tr>
<td>Destiny</td>
<td>Doeskin</td>
<td>Olefin/nylon</td>
<td>$7.56</td>
<td>10 years</td>
<td>No</td>
</tr>
<tr>
<td>Sapelo</td>
<td>Star Gazer</td>
<td>Olefin</td>
<td>$7.47</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Design Zone</td>
<td>Carpet Tile Panel with Pad</td>
<td>Nylon</td>
<td>$10.00</td>
<td>20 years</td>
<td>No</td>
</tr>
<tr>
<td>Mohawk</td>
<td>Everstrand</td>
<td>100% Recycled Plastic Bottles</td>
<td>$13.00</td>
<td>20 years</td>
<td>Yes</td>
</tr>
<tr>
<td>Southern Comfort and Divine Luxury</td>
<td>37% corn; nylon</td>
<td>$21.00</td>
<td>20 years</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Midnight Oasis</td>
<td>37% corn; nylon</td>
<td>$22.00</td>
<td>20 years</td>
<td>Yes</td>
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<tr>
<td>Synergy</td>
<td>344</td>
<td>15% Recycled fibers, nylon</td>
<td>$9.46</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Bamboo Flooring</td>
<td>Bamboo Flooring</td>
<td>Hardwood</td>
<td>$27.00</td>
<td>25 years</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Sources:
TreeHugger.com [http://www.treehugger.com](http://www.treehugger.com)
**Table 9.3b Furniture Options:**

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model/Object</th>
<th>Main Material</th>
<th>Initial Cost</th>
<th>Greenguard* Certified?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knoll Studio</td>
<td>Risom Lounge Chair</td>
<td>Maple and Cotton</td>
<td>$632</td>
<td>Yes</td>
</tr>
<tr>
<td>Izzy Design</td>
<td>Bailey Ergonomic Chair</td>
<td>Nylon, aluminum, foam</td>
<td>$270</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Maxwell Office Chair</td>
<td>Aluminum, foam, plastic</td>
<td>$540</td>
<td>Yes</td>
</tr>
<tr>
<td>Steelcase</td>
<td>Think Chair (Desk chair)</td>
<td>Recycled and new steel</td>
<td>$670</td>
<td>Yes</td>
</tr>
<tr>
<td>Herman Miller</td>
<td>Aeron Chair (Desk chair)</td>
<td>Graphite, Plastic</td>
<td>$750</td>
<td>Yes</td>
</tr>
<tr>
<td>Aruba</td>
<td>Woven Armchair and Ottoman</td>
<td>Banana Rope, Sustainably harvested wood</td>
<td>$1,000</td>
<td>No (but uses sustainable resources)</td>
</tr>
<tr>
<td>Marin</td>
<td>Convertible Sofa (Sofa/Bed)</td>
<td>Sustainably harvested wood, petrochemical-based foam, fiber</td>
<td>$1,000</td>
<td>No (but uses sustainable resources)</td>
</tr>
<tr>
<td>Green Design Furniture</td>
<td>Classic Computer Desk</td>
<td>Sustainable wood</td>
<td>$3,900</td>
<td>No (but uses sustainable resources)</td>
</tr>
<tr>
<td>La-Z-Boy</td>
<td>Argenta Sofa</td>
<td>Leather, Wood, Foam</td>
<td>$1,400</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Calvin Recliner</td>
<td>Leather, Wood, Foam</td>
<td>$800</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Lancer Recliner</td>
<td>Fabric, Wood</td>
<td>$500</td>
<td>No</td>
</tr>
<tr>
<td>Office Star</td>
<td>Mesh Back Task Chair (Desk Chair)</td>
<td>Leather, nylon, polyurethane</td>
<td>$150</td>
<td>No</td>
</tr>
<tr>
<td>OFM Seating</td>
<td>Ergonomic Computer Chair</td>
<td>Fabric, plastic</td>
<td>$130</td>
<td>No</td>
</tr>
<tr>
<td>Bestar Office Furniture</td>
<td>Slate and Sandstone Computer Desk</td>
<td>Fiberboard with slate, sandstone finish</td>
<td>$360</td>
<td>No</td>
</tr>
<tr>
<td>Sauder Office Furniture</td>
<td>Dark Alder Computer Desk</td>
<td>“Environmentally friendly engineered wood”</td>
<td>$160</td>
<td>No (but uses “environmentally friendly wood”)</td>
</tr>
</tbody>
</table>

*Greenguard is an environmentally-friendly certification program through a nonprofit group called Greenguard Environmental Institute. To see many more items than are listed in the above table, visit their website at [http://www.greenguard.org](http://www.greenguard.org)*
Furnishing Plan

Directions: Here is a top view of a living room. Choose a flooring option. Choose furniture for the room. How many square yards (9 square ft) of flooring do you need?
Hint: How many 3 by 3 feet squares can you make on your floor? How much would it all cost? What values did you base your furnishing on?

On a separate sheet of paper, calculate and answer the following:

1. Total flooring needed in square yards
2. Flooring option(s) chosen
3. Price of flooring option(s)
4. Type of furniture purchased
5. Total cost of furniture purchased
6. Values you considered in your purchases
7. How realistic is your plan? Do you believe you would plan this way as an adult?

Bonus. Add photos of your items!
Extension

*Boston Globe* article on indoor toxins from carpeting, wall materials, furniture, 3 pages

**Is your home a health hazard?**

*By Chris Berdik, Globe Correspondent | February 17, 2005*

Back in 1980, Peggy Wolff’s home slowly started poisoning her. Soon after moving into the newly constructed house in Leverett, Wolff, now 59, began to have short-term memory loss and severe problems with her digestion. In a scenario that sounds like a horror-movie plot, the house, built to be airtight and energy efficient, had become a closed system of air contaminated by mold and chemicals emitted by particleboard furniture, paint, carpets, and insulation.

Wolff saw “tons” of doctors, but says, “I didn’t fit into any of the usual categories, and I never really got much better.”

Wolff was experiencing something that more and more public-health officials, interior designers, and home builders are recognizing: the air inside a home, especially a new or remodeled one, can be more polluted than outside air and can sometimes endanger the health of its occupants. And one of the main culprits is a class of chemicals most people have never heard of, even though they’re in all sorts of building materials and household products: volatile organic compounds.

Concerns about VOCs and indoor-air quality are a growing part of the environmentally conscious green-building movement. A national green-building standard has existed for commercial and institutional buildings for nearly five years. But the focus is only now turning to residences, where no national guidelines exist for building “green” with good indoor air quality. Plus, the regulatory definition of VOCs set by the Environmental Protection Agency is based on a chemical’s contribution to smog, an outdoor phenomenon. And finally, there are still relatively few contractors who know much about low- or no-VOC products. That leaves homeowners wondering just how to clear their air with confidence.

VOCs are carbon-based chemicals—including benzene, toluene, and formaldehyde—that evaporate easily at room temperature and are widely used in products from particleboard to carpeting. Most of us can tolerate a moderate amount of them. However, intense exposure, or even low-level exposure over time, can trigger what’s known as Multiple Chemical Sensitivity, like that experienced by Wolff, who eventually had to move from her house. In addition to the risk of triggering severe chemical sensitivities, many VOCs are listed by the Environmental Protection Agency as probable carcinogens. Additionally, studies suggest a link between indoor air contamination and asthma, which grew 60 percent among Americans between 1992 and 2002, to more than 20 million cases, according to the American Lung Association.

While the precise health effects of indoor air contaminants such as VOCs—particularly the mixtures of chemicals in most homes—are not currently known, toxicologist Mark Goldman, senior air-quality specialist for the insurance adjustment firm EFI, says that the 4 percent to 6 percent of the population estimated to be chemically sensitive are “the canaries in the coal mine amongst us,” suggesting that more people could be affected over time. He adds, “We’re dealing with a lot of stuff we don’t understand very well.”

This is why environmental health specialists like Jack Spengler of Harvard’s School of Public Health believe that even people who aren’t striving to have an all-out “green” home should be aware of
indoor-air quality when building, remodeling, or stocking up on kitchen, bathroom, and home-improvement products.

“In general, we should aim to greatly reduce the chemical mix around us,” says Spengler, who is helping to direct research in which volunteers wear air-sampling backpacks to measure contaminant levels in their homes, schools, and office environments. The EPA estimates that indoor air can be up to five times as contaminated with VOCs as outside air, even in cities like Boston.

The time to worry about VOCs is when a house is new or newly refurbished, says Andrea White, a sustainable-design consultant who teaches classes on indoor-air quality at the Boston Architectural Center. This is because VOCs used as solvents or adhesives get into the air by evaporating, or “off-gassing,” which decreases over time but can continue for weeks, months, or even years. “Some of the biggest offenders are found when you’re really finishing off the house, like paints and floor finishes,” advises White.

When paints and stains dry, they can off-gas VOCs such as toluene. Fortunately, paint is one product where most mainstream manufacturers now offer a low- or no-VOC option, such as Benjamin Moore’s Eco Spec (suggested retail, $26 per gallon) and Pure Performance from Pittsburgh Paints (suggested retail, $25 a gallon).

There are also companies that focus on maintaining healthy air, such as AFM Safecoat paints and stains. Some professional painters say low-VOC paint may not provide quite the coverage of regular paint or may dry too quickly. But non-profits like Greenseal and BuildingGreen that promote eco-friendly building recommend low-emitting paints that “work just as well and cost well in line with other high-quality paints,” according to Nadav Malin, editor-in-chief of BuildingGreen’s trade publication, Environmental Building News.

Malin considers no-VOC paint to be the “low-hanging fruit” when it comes to improving a home’s air quality. Things get trickier, however, when it comes to another prime source of VOCs, particleboard and medium-density fiberboard, often used in kitchen cabinets and furniture. For decades, particleboard has been held together with adhesive containing formaldehyde, a probable carcinogen whose inhalation can cause coughing, nausea, and a burning sensation in the eyes, nose, and throat.

The EPA recommends purchasing solid-wood furniture and cabinetry or opting for “exterior grade” particleboard that contains a lower-emitting type of formaldehyde resin. Other options include products made with strawboard or wheatboard that contain no formaldehyde. There are also sealants, such as those made by AFM, that can be applied to normal particleboard to prevent off-gassing. The trade-off for these alternatives is a higher price. “It’s more expensive, because you usually have to go out and search for [non-formaldehyde] products as a special item,” notes White, the sustainable-design consultant. Malin, however, notes that homeowners can also avoid formaldehyde by being “more flexible aesthetically,” and opting for metal cabinets or furniture.

The air we breathe may also be affected by what’s beneath our feet. In one year, American mills produce enough carpet to cover nearly half of Rhode Island, and for more than a decade
environmental health advocates and the carpet industry have been debating the toxicity of what all that carpet puts into the air (primarily, styrene and 4-phenylcyclohexene). In a 1992 agreement with the EPA, the carpet industry agreed to test carpets for VOCs and to provide a “Green Label” only to those with low emissions. Many environmental health advocates remain wary of carpets, however, due to concerns over carpet's ability to harbor mold and other pollutants.

And it's not just how you build and furnish your house that can affect its air quality, it's how you clean and maintain it as well. Many disinfectants, cleansers, paint strippers, and air fresheners contain a cocktail of organic chemicals. A recent study by British researchers, for instance, published in the December issue of the British medical journal Thorax, correlated breathing problems in infants with the use of various cleaning products in the home. Indeed, the Toxic Use Reduction Institute at UMass-Lowell has been partnering with public-housing authorities and school districts around Massachusetts to test low-emitting cleaning and building products, measuring the performance of these products in their “solvent substitution lab.”

Of course, environmental health advocates emphasize that indoor-air quality isn't just about VOCs. There's also mold, fumes from attached garages, and proper ventilation to consider. Unfortunately, there aren't many easy answers.

Seven years ago, when John McTernan, 56, of Wrentham had been diagnosed with cancer, he wanted to build a home with healthy indoor-air quality as part of a holistic approach to healing. Finding resources and expertise was difficult. “We bought books, got on the Internet. It was hard to find an architect who was familiar with [green building],” says McTernan.

He and his wife, Charlet, 54, eventually found an architect in Amherst, Mary Kraus, who knew how to minimize indoor-air contamination. They avoided particleboard by going with solid-wood flooring and antique furniture. They installed a ventilation system and used no-VOC paint. McTernan estimates that he spent about 25 percent more to ensure good indoor-air quality, which he partly blames on how difficult many products were to find at the time.

Today, there are more resources for homeowners looking to build green and improve the health of their indoor environments. Over the past few years, there has been a surge of interest in green building and healthy indoor-air quality in the commercial and institutional realm, as exemplified by the Green Building Task Force convened last fall by Boston Mayor Thomas Menino. Some of that expertise has slowly filtered into the consumer market. This year, the US Green Building Council, which created the national green standard in commercial buildings, will pilot a residential standard called LEED for Homes.

Malin, of Environmental Building News, thinks having a national standard for homes will make a big difference, offering corporations, consumers, and homebuilders the consistency needed to create demand and market incentives. “I think for a lot of people, the health of their families is a top priority. It's a good hook to get a lot of people interested in green building,” says Malin. “But there's a lot to understand. It's not simple stuff. And unless there's a clear, simple path a homeowner can follow to make their home a green home, it's going to be the rare person who's willing to do the research.”


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Learning Objectives

1. Students will collect many options for proper disposal and reuse of everyday items.
2. Students will gather statistics on these items and create a poster describing their current life cycle, and how we can change the life cycles to use these items more sustainably.

Materials

- **Skill Building: Local Resource List** of donation centers, thrift stores, hazardous waste disposal sites
- **Skill Building: Disposal of Hazardous Materials**
- Poster paper
- Art supplies
- Computers and printer
- Calculators
- Shirt or pants in decent shape
- **Skill Building: Saving Space in Landfills**

Preparation

- Several visual aides are provided in this unit. The teacher may also want to prepare his/her own visual/kinesthetic aides for class.

Hour 1

(5 min) Anticipatory Set: Hold up a shirt and tell students that you just don’t want to wear this shirt any more. What are your options? Garner a few responses from students. (disposal, give to a friend, use as rags, donate it).

(20 min) Presentation: Congratulate students on list of ideas. On the board or poster paper, draw a table with two headings. One should read “reusable/recyclable” and one should read “disposable” (you may also split up the reusable/recyclable heading into two separate headings). Explain to students that under the reusable/recyclable heading, you will write items that, once used, can either be reused or recycled. This could include items to be donated. Under the disposable heading, you will write items that must be sent to the landfill or a hazardous waste disposal site (where it may yet be recycled by the proper experts).

(35 min) Group Work: Distribute Disposal of Hazardous Materials list to be completed as a whole group. Use teacher answer key to instruct students about what they should do with each type of waste.


Independent or Group Work: Distribute Local Resource List of donation centers, thrift stores, and hazardous waste disposal sites

Students may use the Internet or phone book to fill in blanks; Alternatively, teacher can use an answer key to tell students what to fill in

Hour 2

(60 min) In pairs, students will choose one hazardous waste item, one clean recyclable item, and one reusable item to research and create posters for. You may differentiate by making larger groups, or shortening this assignment.

Student posters will reflect the source of the item, the use of the item, proper disposal options for the item, and local resources, with address/phone number/website if applicable, that will handle the item after disposal. Students should include a visual of the item they are describing, as well as a title, their names. Formatting is up to the teacher, as are writing and typing requirements.
Hour 3
(50 min) Finish up posters, presentation (optional)
(10 min) Conclusion: Reflecting upon the sustainability at home unit, students will draw up an action plan of 3-5 lifestyle changes they believe they can make, when they will be able to make them, and how the actions will serve the environment and save money and resources.

Assessment
1. Students will be working on posters for more than one class period. Teachers will assess posters based on the required elements of the poster.
2. When posters are finished, students should Skill Building: Saving Space in the Landfills worksheet.
3. Upon completion of all required elements, students should present posters to class, and post them in the room or hallway.

Lesson Extension
The teacher may have students create a Saving Space in the Landfills worksheet based on the statistics of their items. Photocopy the practice sheets and distribute to classmates!
Local Resource List

Directions: Help create a Local Resource List of donation centers and thrift stores. Look up nearby recycling centers, thrift stores, and hazardous waste disposal sites. Fill in the name, address, phone number and website, if applicable.

<table>
<thead>
<tr>
<th>Recycling Centers:</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td><strong>Address</strong></td>
<td><strong>Phone Number</strong></td>
<td><strong>Website</strong></td>
<td><strong>Hours of Operation</strong></td>
</tr>
<tr>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Thrift/second-hand stores:</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td><strong>Address</strong></td>
<td><strong>Phone Number</strong></td>
<td><strong>Website</strong></td>
<td><strong>Hours of Operation</strong></td>
</tr>
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</tbody>
</table>
### Disposal of Hazardous Materials

Directions: Fill in the name, address, phone number, hours of operation, and website, if applicable, of local resources for hazardous waste disposal.

<table>
<thead>
<tr>
<th>Type of Hazardous Waste</th>
<th>Name of Disposal Site</th>
<th>Telephone Number</th>
<th>Website and Hours of Operation</th>
<th>Name of Disposal Site</th>
<th>Telephone Number</th>
<th>Website and Hours of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning products (bleach, floor cleaner, drain cleaner)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rechargeable batteries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lawn Chemicals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automotive products chemicals (used oil, antifreeze)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluorescent light bulbs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pesticides, repellents and poisons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flammable petroleum products (gas, diesel, kerosene)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Saving Space in the Landfills: Paper and Plastic

Remember: Show your work and make sure you use the correct label on all your answers!

Directions: Using information provided, solve the problems. You will get large numbers. Make sure you have a calculator that you know how to read properly! An alternative idea would be to do calculations in Microsoft Excel.

<table>
<thead>
<tr>
<th>Important Data:</th>
<th>Formula:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Paper occupies about 50% of all waste in landfills</td>
<td>Cubic yards are used to measure volume of trash in the USA. A cubic yard is 3 ft × 3 ft × 3 ft, or 27 cubic feet.</td>
</tr>
<tr>
<td>• Plastic consumes about 15% of all waste in landfills</td>
<td></td>
</tr>
</tbody>
</table>

1. If you collected 4 cubic yards of trash, how many cubic feet would that be?

2. If you randomly collected 4 cubic yards of trash from your local landfill, how many cubic yards would you expect to be paper? Convert this number into cubic feet.

3. If you collected 4 cubic yards of trash from your local landfill, how many cubic yards would you expect to be plastic? Convert this number into cubic feet.

4. United States citizens send about 255.329 billion pounds of trash to landfills every year. (And this is only half of our total trash!) The average density in a landfill is 1500 pounds (lb) per cubic yard. Using dimensional analysis, find the total volume of trash Americans contribute to landfills every year.

5. How many cubic yards of paper is that? Of plastic? If we recycled all our paper and plastic, this is how much we would keep out of landfills.
   Paper-
   Plastic-

Sources:
1. Earth and Sky.org. How long would it take to fill up the Grand Canyon with trash?
Unit Answer Keys

Some of the answers will be shown in steps to guide instruction. The steps will be separated by arrows.

Lesson 1

<table>
<thead>
<tr>
<th>Skill Building: Calculation Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $14.78</td>
</tr>
<tr>
<td>2. $6.34</td>
</tr>
<tr>
<td>3. $16.47 in savings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skill Building: Mock City Energy Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A majority of the energy use is renewable (52%)</td>
</tr>
<tr>
<td>2. 160 megawatts</td>
</tr>
<tr>
<td>3. 600 more megawatts</td>
</tr>
</tbody>
</table>

Lesson 3

<table>
<thead>
<tr>
<th>Skill Building: Calculating Prices for Insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $246.82</td>
</tr>
<tr>
<td>2. $800.00</td>
</tr>
<tr>
<td>3. a. US green fiber</td>
</tr>
<tr>
<td>b. green fiber natural</td>
</tr>
<tr>
<td>c. owens corning</td>
</tr>
</tbody>
</table>

Lesson 4

<table>
<thead>
<tr>
<th>Skill Building: Comparing Yearly Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CFL: 14, 0.014, 0.084, $3.07</td>
</tr>
<tr>
<td><strong>Incandescent:</strong> 60, 0.06, 0.36, $13.14</td>
</tr>
<tr>
<td><strong>Annual Cost Savings:</strong> $10.07 per year</td>
</tr>
<tr>
<td>2. CFL: 20, 0.02, 0.12, $4.38</td>
</tr>
<tr>
<td><strong>Incandescent:</strong> 75, 0.075, 0.45, $16.43</td>
</tr>
<tr>
<td><strong>Annual Cost Savings:</strong> $12.05 per year</td>
</tr>
<tr>
<td>3. CFL: 26, 0.026, 0.156, $5.69</td>
</tr>
<tr>
<td><strong>Incandescent:</strong> 100, 0.1, 0.6, $21.90</td>
</tr>
<tr>
<td><strong>Annual Cost Savings:</strong> $16.21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skill Building: Lighting Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $30.21</td>
</tr>
<tr>
<td>2. $48.20</td>
</tr>
<tr>
<td>3. 3.75</td>
</tr>
</tbody>
</table>
### Lesson 6

**Skill Building: Measuring Loads**

1. **In use load:** $0.20  
   **Phantom load:** $0.93  
   **Sum:** $1.13  
   **Annual load:** $13.56

2. **In use load:** $0.16  
   **Phantom load:** $3.45  
   **Sum:** $3.61  
   **Annual load:** $43.32

3. **$743.04**

### Lesson 7

**Skill Building: Calculating FSC-Certified Wood Costs**

<table>
<thead>
<tr>
<th>“Normal” wood cost</th>
<th>Low estimate FSC cost (“normal” + 0.5%)</th>
<th>Mid-range estimate FSC cost (“normal” + 1.5%)</th>
<th>High estimate FSC cost (“normal” + 2.5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$100</td>
<td>$100.50</td>
<td>$101.50</td>
<td>$102.50</td>
</tr>
<tr>
<td>$1,000</td>
<td>$1,005.00</td>
<td>$1,015.00</td>
<td>$1,025.00</td>
</tr>
<tr>
<td>$20,000</td>
<td>$21,100.00</td>
<td>$20,300</td>
<td>$20,500.00</td>
</tr>
<tr>
<td>$50,000</td>
<td>$50,250.00</td>
<td>$50,750.00</td>
<td>$51,250.00</td>
</tr>
<tr>
<td>$100,000</td>
<td>$100,500</td>
<td>$101,500</td>
<td>$102,500.00</td>
</tr>
</tbody>
</table>

### Lesson 9

**Skill Building: Saving Space in the Landfills**

1. **108 ft³**
2. **54 ft³**
3. **16.2 ft³**
4. **170,219,333.3 yd³**
5. **Paper:** 85,109,666.65 yd³  
   **Plastic:** 25,532,900 yd³
Unit References

27. Portage, Wis. area thrift stores: