



# The Life Cycle of a Cell Phone

You have one, your parents have one, your friends each have one—owning a cell phone has become as common as having a traditional land-line in your home. More than 156 million Americans now use cell phones—including about 20 percent of American teens! In a way, cell phones have become a necessity of everyday life—we use them to call home when we're late, make plans with friends, or get directions when we're lost. But have you ever thought about how cell phones are made and what happens to them when you don't need them anymore?

Like any product, making a cell phone and its parts uses natural resources and energy, which can potentially impact the air, land, and water. Understanding the life cycle of a product can help you make environmental choices about the products you use, and how you dispose of them. **You** can help minimize your environmental impact of using a cell phone by:

**★ Keeping your phone longer.** Choose your cell phone service provider carefully. Pick a phone with features you need and a style you like so you will keep it longer.

**★ Charging your battery correctly.** Increase the life span of your phone and battery by following the manufacturer's directions for charging the battery.

**★ Reusing or recycling your phone.** Find ways to reuse or recycle your phone and accessories when you're finished with them. Many companies recycle or reuse cell phones—visit the "Resources" section of this poster for a list of suggestions.

Follow the life-cycle diagram to learn more about cell phones, their parts, and their potential impact on the environment...

## Materials Extraction

A cell phone is made up of many materials. In general, the handset consists of 40 percent metals, 40 percent plastics, and 20 percent ceramics and trace materials.

The **circuit board** (also called a printed wiring board), located in the handset, is the "brain" of the cell phone because it controls all of its functions.

Circuit boards are made from mined, raw materials including copper, gold, lead, nickel, zinc, beryllium, tantalum, coltan, and other metals. The manufacturing of these boards requires crude oil for plastic, and sand and limestone for fiberglass. Many of these materials are known as "persistent toxins" and can stay in the environment for long periods of time, even after disposal.

The **liquid crystal display (LCD)** is a low-power, flat-panel display on the front of your phone that shows information and images. It becomes opaque (hard to see through) when electric current passes through it. The contrast between the opaque and transparent (see-through) areas forms visible characters.

Approximately 20 percent of American teens (more girls than boys) own a cell phone. By the end of 2005, nearly two-thirds of all U.S. teens will be wireless!

Various liquid crystalline substances, either naturally occurring (such as mercury, a potentially dangerous substance) or human-made, are used to make LCDs. LCDs also require the use of glass or plastic.

The **rechargeable battery** is used to power the phone.

Cell phones can use several types of batteries: nickel-metal hydride (Ni-MH), lithium-ion (Li-Ion), nickel-cadmium (Ni-Cd), or lead acid. Ni-MH and Ni-Cd batteries contain nickel, cobalt, zinc, cadmium, and copper. Li-Ion batteries use lithium metallic oxide and carbon-based materials, all mined from the earth.

## Using Less Stuff

Cell phone companies have made great strides in "dematerialization" (using less materials) as shown by the decreasing size of today's cell phones. Years ago, the technology needed for a cell phone would have filled the entire floor of an office building; now everything needed for a cell phone weighs only 7.7 ounces!

## Materials Processing

Most raw materials must be processed before manufacturers can use them to make products. For example, in cell phones:

- Crude oil is combined with natural gas and chemicals in a processing plant to make plastic;
- Copper is mined, ground, heated, and treated with chemicals and electricity to isolate the pure metal used to make circuit boards and batteries. The resulting copper pieces are shipped to a manufacturer where they are formed into wires and sheets.

## Manufacturing

Plastics and fiberglass are used to make the basic shape of the **circuit board**, which is then coated with gold plating. The board is also composed of several electronic components, connected with circuits and wires (primarily made of copper) that are soldered to the board and secured with protective glues and coatings.

LCDs are manufactured by sandwiching liquid crystal between layers of glass or plastic.

**Batteries** consist of two separate parts, called electrodes, made from two different metals. A liquid substance, called electrolytes, touches each electrode. When an outside source of electricity such as an outlet is applied, chemical reactions between the electrodes and the electrolytes cause an electric current to flow, giving batteries their "juice" or power.

By 2005, cell phones will be discarded at a rate of more than 125 million phones each year, resulting in more than 65,000 tons of waste!

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## Materials Extraction

## Materials Processing



## Disposal

Today, more than 1.2 billion cell phones are in use worldwide.

## Recycling

## Manufacturing

## End-of-Life



## Reuse

## Useful Life

## Packaging & Transportation

Between 1999 and 2003, 2.5 million phones were collected to be recycled or reused, accounting for less than 1 percent of the millions of phones retired or discarded each year.

## Packaging & Transportation

Cell phone parts and the finished products need packaging and transportation to get from one place to another. Transportation by plane, truck, or rail all require the use of fossil fuels for energy, which can contribute to global climate change.

While packaging protects products from damage, identifies contents, and provides information, excessive or decorative packaging can be wasteful. Packaging consumes valuable natural resources, such as paper (from trees), plastic (from crude oil in the earth), aluminum (from ore), or other materials, all of which use energy to produce and can result in waste. Some packaging, however, can be made from recycled materials.

In 1985, about 340,000 people used cell phones in the United States; in 2003, more than 140 million people used cell phones.

## Useful Life

Unlike other countries, cell phone companies in the United States sell their own phones, which are usually not interchangeable from company to company. Even though regulations now allow consumers to transfer their phone number to a new phone company, most companies have unique technologies in their phones that only work in their own networks. This means that switching cell phone companies can mean having to purchase a new phone. One way to extend the useful life of your phone and prevent waste is to use the same company for continuing phone service. Always comparison-shop to be sure you get the service and phone that's right for you.

Cell phones are only used for an average of 18 months before being replaced—even though they can function for much, much longer.

You can also extend the life of your phone by taking care of it—protecting it from damage by storing it in a case, avoiding dropping it, and keeping it out of extreme heat and cold and away from water and other liquids.

The use of **rechargeable batteries** in cell phones reduces the amount of waste and toxicity that disposable batteries create. Be sure to follow the manufacturer's instructions for charging your batteries so you can extend their lives as long as possible.

## End-of-Life

Donating or recycling cell phones when you no longer need or want them extends their useful lives, and prevents them from ending up in the trash where they can potentially cause environmental problems.

**Reuse**  
Many organizations—including recyclers, charities, and electronics manufacturers—accept working cell phones and offer them to schools, community organizations, and individuals in need. Reuse gives people, who could not otherwise afford them, free or reduced cost access to new phones and their accessories. Plus, it extends the useful lifetime of a phone.

## Take-Back Programs

Many cell phone manufacturers and service providers offer a "take-back" program. Under this system, manufacturers accept used cell phones and accessories and either recycle, re-manufacture, or dispose of them using systems designed to handle the specific types of waste cell phones produce. Contact your manufacturer by using the information that came with your phone or via the Internet.



## Recycle

Electronics recyclers are springing up everywhere! Today, many stores, manufacturers, and recycling centers accept cell phones for recycling. While some electronics recyclers only accept large shipments, communities, schools, or groups can work together to collect used cell phones for shipment to electronics recyclers.

Some rechargeable batteries can also be recycled, as several retail stores and some communities have started collecting them. When rechargeable batteries are recycled, the recovered materials can be used to make new batteries and stainless steel products.

Check the "Resources" section of this poster for a list of organizations that will accept your phone and accessories for reuse or recycling. You can also use the Internet or phone book to search for local contacts that recycle and refurbish cell phones.

**Disposal**  
By 2005, the rate at which cell phones are discarded is predicted to exceed 125 million phones each year, resulting in more than 65,000 tons of waste! Cell phones that are thrown in the trash end up in landfills (buried in the ground) or incinerators (burned). Because cell phones contain metals, plastics, chemicals, and other potentially hazardous substances, you should always recycle, donate, or trade in your old cell phone. It's free and easy. Don't throw it away! Phones that are thrown away waste energy and result in the loss of valuable resources.

## Crank up the Volume

A major cell phone manufacturer recently developed a way to recharge cell phone batteries using "muscle power." This hand-powered device provides 20 minutes of talk time after just three minutes of squeezing a hand-held generator! Other new technologies, such as hydrogen fuel cells and zinc-air and solar-powered batteries, are under development and might ultimately replace current battery technology. These new alternatives will conserve natural resources and reduce waste.



## The Nine Lives of a Cell Phone

Cell phones consist of nine basic parts, each of which has its own life cycle:

- Circuit board/printed wiring board
- Battery
- Antenna
- Keypad
- Microphone
- Speaker
- Plastic casing
- Accessories (such as adapters, headsets, carrying cases, and decorative face plates)





# What is a Life Cycle?

Have you ever considered where the products you use every day come from, or what happens to them when you finish using them? Do you know how each of the products you use impacts the environment?

Just as living things are born, get older, and die, products also complete a life cycle. Each stage of a product's life cycle can affect the environment in different ways. Some products, such as cell phones, have many different components, each of which has its own life cycle in addition to the life cycle of the composite product. The stages of a product's life cycle usually include:

**★Design.** A product's design can influence each stage of its life cycle and in turn the environment. Design affects which materials will be used to manufacture a product. For example, cheaper materials are often less durable, which means the product will have a short useful life. Product design can also prevent waste in many ways. Products can be designed with modular components that can be easily replaced so that the entire product does not have to be thrown away if only one piece breaks. Items meant to last a long time can avoid trendy designs so they are not thrown away when they go out of style.

**★Materials Extraction.** All products are made from materials found in or on the earth. "Virgin" or "raw" materials, such as trees or ore, are directly mined or harvested from the earth, a process that can create pollution, use large amounts of energy, and deplete limited natural resources. Making new products from materials that have already been used (recycled materials) can reduce the amount of raw materials we need to take from the earth.

**★Materials Processing.** Once materials are extracted, they must be converted into a form that can be used to make products. For example, paper is made from trees, but the wood has to undergo several different processes before we can use it.

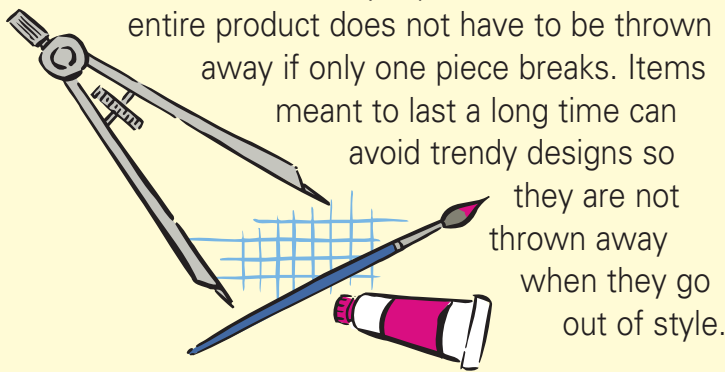
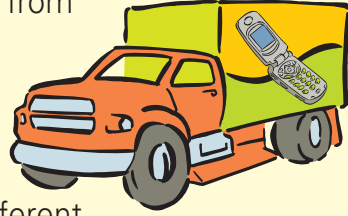
**★Manufacturing.** Products are made in factories and require a great deal of energy to create. The manufacturing process can also produce pollution. Many products require the use of packaging as well, to prevent spoilage, damage, contamination, and tampering.

**★Packaging & Transportation.** The use of packaging can protect products from damage and provide product information. However, packaging consumes valuable natural resources and when used excessively can be wasteful. Some packaging can be made from recycled materials.

Finished products are transported in trucks, planes, and trains to different locations where they are sold. All of these forms of transportation burn fossil fuels, which can contribute to global climate change.

**★Use.** The way products are used can impact the environment. For example, products that are only used once create more waste than products that are used again and again.

**★Reuse/Recycling/Disposal.** Using a product over and over again prevents the need to create the product from scratch, which saves resources and energy while also preventing pollution. Recycling or re-manufacturing products also reduces the amount of new materials that have to be extracted from the earth. Throwing a product away means that it will end up in a landfill or incinerator and will not be useful again.



**★National Recycling Coalition's (NRC's) Electronic Recycling Initiative**  
[www.nrc-recycle.org/resources/electronics/index.htm](http://www.nrc-recycle.org/resources/electronics/index.htm)  
 NRC's Electronics Recycling Initiative promotes the recovery, reuse, and recycling of obsolete electronic equipment.

**★U.S. Environmental Protection Agency, Product Stewardship Program**  
[www.epa.gov/epr](http://www.epa.gov/epr)  
 This program provides information on life cycle environmental impacts of products.

**★U.S. Environmental Protection Agency, Green Engineering Program**  
[www.epa.gov/opptintr/greenengineering](http://www.epa.gov/opptintr/greenengineering)  
 This program advocates designing products with their entire life cycle in mind.

**★United Nations Environment Programme, Life Cycle Initiative**  
[www.unepie.org/pc/sustain/lca/lca.htm](http://www.unepie.org/pc/sustain/lca/lca.htm)  
 This web site provides information about products and services over their entire life cycle.

**★HowStuffWorks.com, Inc.**  
[www.howstuffworks.com/cell-phone.htm](http://www.howstuffworks.com/cell-phone.htm)  
 This web site provides a straightforward and easy-to-read discussion of the technical components of a cell phone and the technology that makes it work.

**★Electronic Industries Alliance (EIA)**  
[www.eia.org](http://www.eia.org)  
 A trade association for the electronics industry, EIA maintains information on how member companies are incorporating environmental attributes into electronic products.

## Resources



### Options for Reuse & Recycling

**★Collective Good**  
[www.collectivegood.com](http://www.collectivegood.com)  
 Collective Good refurbishes donated cell phones and uses them to provide affordable wireless service throughout the Caribbean and Latin America.

**★Cellular Telecommunications & Internet Association (CTIA)**  
[www.ctia.org](http://www.ctia.org)  
 CTIA is an international association for the wireless telecommunications industry.

**★Charitable Recycling**  
[www.charitablerecycling.com](http://www.charitablerecycling.com)  
 Charitable Recycling Program encourages the donation of used cell phones.

**★Plug-in to eCycling Program**  
[www.plugintocycling.org](http://www.plugintocycling.org)  
 EPA, in partnership with several companies and organizations, is helping consumers of electronic products tap into a network of recycling opportunities nationwide.

**★ReCellular, Inc.**  
[www.recellular.com](http://www.recellular.com) or [www.wirelessrecycling.com](http://www.wirelessrecycling.com)  
 ReCellular, Inc. is a recycler and reseller of used wireless phones and accessories.

**★Rechargeable Battery Recycling Corporation (RBRC)**  
[www.rbrc.org](http://www.rbrc.org)  
 RBRC is a nonprofit, public service organization that recycles rechargeable batteries.

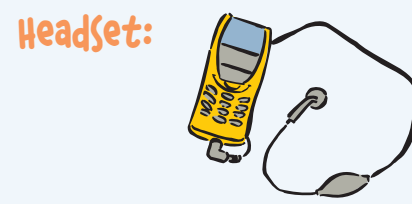
**★The Wireless Foundation**  
[www.wirelessfoundation.org](http://www.wirelessfoundation.org)  
 Established by CTIA, this foundation is involved with several programs that use wireless communications to make communities safer, families more secure, and teachers more effective.

## Hand-Held Hunt



Whether at school, home, or out running errands, people use hand-held electronic devices everywhere they go. Take an informal survey to find out who uses the following items in the various locations you visit during a single day. This activity will illustrate how many people own and use cell phones and their accessories. You may discover interesting trends in who is buying and using cell phones and their accessories in your community!

Consider whether the people are kids, teenagers, or adults and whether they are male or female. For example, spend a half-hour at the mall and identify how many people in each category are using the items listed below. Perhaps adult men use belt clips more than younger women. Is that true? Find answers to these questions, and turn your results into a graph or chart.



**Headset:** Many people use a cell phone headset while they are driving or walking around to keep their hands free. Most models of headsets can be reused when you buy a new phone.



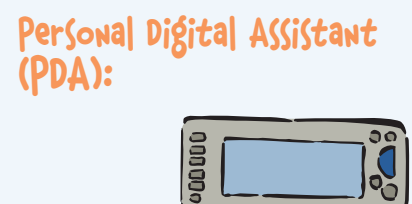
**Belt clip:** Some people buy belt clips to carry cell phones while not in use. Reusing or donating your belt clip when you are finished using it prevents waste.



**Face plate:** Decorative face plates can be trendy and fun, but you don't need them to use a cell phone. The best way to prevent waste is to simply not buy products you don't need. If you do buy face plates, donate unwanted ones to a charity or swap them with your friends instead of throwing them away.



**Portable games and CD players:** Cell phones have a lot of the same parts as hand-held video game consoles and portable CD players, including speakers, circuit boards, and LCDs. Old or broken consoles and players can also be reused or recycled when no longer wanted.



**Personal Digital Assistant (PDA):** Advances in cell phone technology have given phones many uses, such as storing phone numbers and searching the Internet. An emerging trend is to create one device with many uses, such as a PDA that also functions as a cell phone. This consolidation reduces waste by reducing the number of individual items a person has to buy.

## Components Crossword

Use the following clues about the different parts of a cell phone to fill in the crossword.

### Across

- The battery, the LCD, and the \_\_\_\_\_ board create 98 percent of a cell phone's environmental impacts.
- Cell phones that are thrown away waste energy and result in the loss of valuable \_\_\_\_\_.
- Each part of a cell phone must be \_\_\_\_\_ and transported, which requires energy and often creates waste.
- Some facilities will recycle \_\_\_\_\_ batteries when they can no longer be reused.
- Cell phones are actually not phones at all but sophisticated two-way \_\_\_\_\_.
- LCDs are a low-power, flat panel display made by sandwiching liquid \_\_\_\_\_ between layers of glass or plastic.

### Down

- Circuits and wires on a circuit board are primarily made from \_\_\_\_\_.
- Ni-MH and Ni-Cd batteries contain nickel, cobalt, cadmium, \_\_\_\_\_, and copper, metals that need to be mined and processed, which creates pollution and waste.
- Many cell phone parts can be removed from the phone and \_\_\_\_\_ or recycled.
- Batteries consist of two separate parts, called \_\_\_\_\_.
- Plastics and \_\_\_\_\_ are used to make the basic shape of a circuit board.
- Crude oil is combined with natural gas and chemicals to make \_\_\_\_\_.



## The Big Debate: Reuse, Recycle, or Dispose?

Cell phones are complicated products, which makes recycling or disposing of them just as complicated. This activity examines options for reusing, recycling, or disposing of cell phones at

the end of their useful life. It can be a research project for individuals or assigned to teams for discussion.

- What are some of the end-of-life options for cell phones? List the options and discuss the pros and cons of each.

PROS	CONS
_____	_____
_____	_____
_____	_____

- Find out what cell phone manufacturers, recyclers, and local authorities have to say about end-of-life options for cell phones.

- ★ Conduct Internet research or call a company that produces cell phones. Find out what it considers to be the useful life of a cell phone. Ask what the policy is for accepting its cell phones back for recycling or remanufacturing.
- ★ Find out what your teachers do with their cell phones at the end of their useful life.
- ★ Contact a local recycling center and ask it if accepts old cell phones.
- ★ Contact a cell phone recycler to learn about its recycling practices and what products are made from recycled cell phones.
- ★ Contact your local waste management agency and ask what its policy is regarding discarded cell phones.

- After conducting this research, write a summary of your findings, including who you contacted, the date, and what information you obtained. Or, present the results to your classmates and discuss what you view to be a good end-of-life choice for cell phones.

## Math Activity 1: Cell Phone Users

- Cell phone users in the United States increased from 340,000 people in 1985 to approximately 140 million people in 2003.
  - This means that on average, how many NEW cell phone users are there per year?
  - In 2003 there were roughly \_\_\_ times more American cell phone users than in 1985.
- Approximately 20 percent of teenagers in the United States own a mobile phone.
  - If 200 teenagers go to your school, about how many of them own a cell phone?
  - What if 1,500 teenagers go to your school? Then about how many own a cell phone?

## Math Activity 2: On-Hold

- Did you know that, on average, cell phones are used for only 18 months before being replaced? Most unused phones are stored in drawers or closets before eventually being thrown away. In fact, more than 30 million mobile phones are lying unused in American homes and businesses.
  - If a person buys a new cell phone every 18 months, how many phones will they buy in 6 years?
- Starting in 2005, it is predicted that more than 125 million cell phones—65,000 tons of waste—will be discarded annually. This potentially serious environmental problem can easily be avoided by understanding how to reuse and recycle phones, prolonging their useful life.
  - Suppose that 300 million cell phones have already been discarded by the end of 2004. Using the cell phone discard rate above, how many TOTAL cell phones will be discarded by the end of 2005?
  - At the predicted 2005 rate of discarding cell phones, how many years will it take to discard 750 million phones?
  - 750 million discarded cell phones is equal to \_\_\_ tons of waste?
  - Can you name three alternatives to throwing out your cell phone?

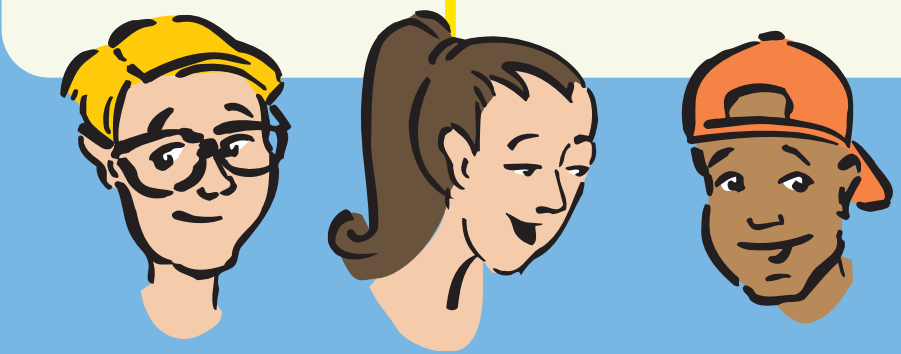
## Words from the wise

Some of the things that are part of your every day life didn't exist when your grandparents were your age. While we might think we need these things, many people got along fine without them in times past.

First, write down your views on whether the following items are necessary or optional, and why. Then interview an older relative or friend (more than 50 years old) to ask what they think about the same things. Compare and discuss your answers. How different or similar are they? Why? Discuss how new products reduce waste, and how new products increase waste.

Compare your thoughts on the following items with those of someone older than you. Here's how:

Item	Your Thoughts	Older Generation's Thoughts
Microwave oven		
Cell phone		
Pager		
Camera		
Compact disc		
Video game		
Radio		
Sport utility vehicle		
Computer		
VCR		
Answering machine		



**EPA**  
 United States Environmental Protection Agency  
 Solid Waste and Emergency Response (5305W)  
 EPA530-H-04-002  
[www.epa.gov/osw](http://www.epa.gov/osw)  
 August 2004

Answers	Math Activity 1:	Math Activity 2:	Components Crossword:
1. A. Roughly 7,758,889 (140 million - 340,000) / 18	1. A. 4	1. A. 4	1. Circuit
2. A. 40 (390,000 tons: (750 million / 125) x 65,000)	2. A. 425 million; 300 million + 125 million	2. A. 425 million; 300 million + 125 million	2. Resources
B. 300 (390,000 tons: (750 million / 125) x 65,000)	B. 6 years: (750 million / 125 million)	B. 6 years: (750 million / 125 million)	3. Reused
			4. Resources
			5. Electrodes
			6. Fiberglass
			7. Packaged
			8. Plastic
			9. Rechargeable
			10. Radios
			11. Crystal