

## Toxic Bulbs

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More consumers are placing compact fluorescent light bulbs (CFLs) in their shopping baskets. Using 25 percent the energy of standard incandescent light bulbs (and lasting 10 times longer), the swirly little tubes have become a symbol of green living and a means to fight climate change. Yet CFLs have a downside: the bulbs contain mercury and cannot be tossed out with the ordinary trash.



## SENCER Approach

You will put your scientific knowledge and mathematical skills to immediate use in understanding CFL-related environmental issues. After you read an assigned article, you will answer questions and perform mathematical calculations involving

- (a) percents
- (b) number sense
- (c) solving equations
- (d) linear functions

Reading: David Appell, "Toxic Bulbs," *Scientific American*, October 2007, pp 30–31.

## ENVIRONMENT

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Recycling rules vary for mercury-containing fluorescents **BY DAVID APPELL**

**M**ore consumers are placing compact fluorescent lightbulbs (CFLs) in their shopping baskets. Using 25 percent the energy of standard incandescents (and lasting 10 times longer), the swirly little tubes have become a symbol of green

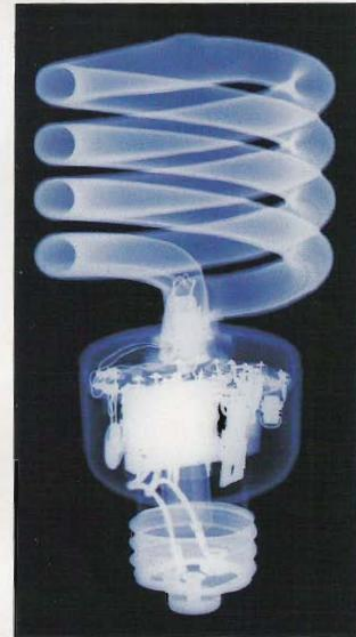
living and a means to fight climate change. Australia will require homeowners and businesses to replace all incandescents with CFLs by 2010, ultimately reducing greenhouse gas emissions by four million metric tons a year. At least four U.S.

states and Congress are considering similar legislation.

Yet CFLs have a downside: the bulbs contain mercury and cannot be tossed out with the ordinary trash. Roughly two billion will be sold in the U.S. this year (about 5 percent of the total lightbulb sales)—raising questions of how to handle 10 metric tons of mercury each year after the bulbs burn out.

Mercury is essential to the function of fluorescent bulbs. An electrostatic charge vaporizes the mercury and induces it to emit ultraviolet light, which makes the phosphorous coating inside the bulbs glow. A potent neurotoxin, mercury is especially dangerous for fetuses and children. In the U.S. today about one sixth of children are born having been exposed to mercury levels so high they are at risk for memory loss and learning disabilities, according to the Environmental Protection Agency.

Each CFL contains about five milli-



**FIXTURE IN A GREEN HOME:** Compact fluorescent bulbs use less energy than standard incandescent bulbs, but because they contain mercury, they pose an environmental risk of their own.

**Reading:** David Appell, “Toxic Bulbs,” *Scientific American*, October 2007, pp 30–31 (continued from last page).

grams of mercury, about equal to the amount of ink on the tip of a ballpoint pen. Of course, mercury in a CFL does not pose the same kind of risk as, for instance, mercury in fish (the U.S. Food and Drug Administration sets a limit of 0.17 milligram in a six-ounce can of tuna). But it can leach out of landfills into water supplies or become airborne if incinerated.

Despite years of effort, manufacturers have failed to find a replacement for mercury, although they have succeeded in reducing the amount of mercury per bulb. “Manufacturers have grown more obvious in their attention to the mercury content of lamps,” says Bill Stanwood of the Product Stewardship Institute, a Boston-based nonprofit that seeks to reduce the health and environmental impact from consumer goods. Whereas industrial users are familiar with the need to recycle linear tubes, residential consumers have yet to catch on—the recycling rate for fluorescent bulbs in the U.S. is about 24 percent, according to the Association of Lighting and Mercury Recyclers. “About one third of the country lives where you can’t throw this stuff into the garbage legally,” says the association’s Paul Abernathy.

Currently CFL recycling options vary across the country. Sylvania offers a mail-back recycling kit that costs about \$1 a bulb. Wal-Mart, which last year an-

nounced a goal of selling 100 million CFLs annually, now has kiosks for spent CFLs, but only in its California stores. The U.S. Postal Service is considering a recovery program with recycling containers at their stations.

At least one state is showing that CFL recycling is economically feasible. Vermont has one of the highest levels of CFL sales per household, and in 1998 it was the second state (after Minnesota) to pass a law requiring the recycling of CFLs. In August 2005 True Value hardware stores in Vermont began taking back customer’s spent bulbs and shipping them back to warehouses on merchandise-delivering trucks. This “reverse distribution” process costs about 35 cents per bulb, says Karen Knaebel, Mercury Education and Reduction Coordinator for Vermont’s

Department of Environmental Conservation. (A state survey found that two thirds of Vermonters would pay 50 cents to recycle a bulb.)

With this strategy, Vermont has recycled 13,000 linear feet of traditional fluorescent lighting and 4,000 CFLs in almost two years. The recycling rate is currently increasing at 17 percent a year.

Stanwood’s organization hopes to translate that kind of success to the rest of the country. His group is working on a plan to facilitate a national dialogue among interested parties to establish more standardized procedures for CFL recycling. But until they are set, consumers who want to recycle will have to fend for themselves once the lights go out.

*David Appell lives in Portland, Ore.*

## And If You Break a CFL ...

Although compact fluorescent lightbulbs contain mercury, breaking one in your home will not require a costly visit by a hazmat team. Open windows to dissipate mercury vapor. Then, while wearing gloves, use sticky tape to pick up the small pieces and powdery residue from the bulb’s interior. Place the tape and large pieces of the bulb in a plastic bag. After vacuuming the area, place the vacuum bag inside doubly sealed plastic bags before discarding.

Check the Environmental Protection Agency’s Energy Star Web site, [www.energystar.gov/index.cfm?c=cfls.pr\\_cfls](http://www.energystar.gov/index.cfm?c=cfls.pr_cfls), for more information.

To find a CFL recycling program in your area, go to [www.lamprecycle.org](http://www.lamprecycle.org)

### Sample Problem

Energy experts tell us to replace regular incandescent light bulbs with compact fluorescent bulbs, but it seems hard to justify spending \$15 on a light bulb. A 60 W incandescent bulb costs 50 cents and has a lifetime of 1000 hours. A 15 W compact fluorescent bulb produces the same amount of light as a 60 W incandescent bulb and is intended as a replacement. It costs \$15 and has a lifetime of 10,000 hours. Compare the *life-cycle costs* of 60 W incandescent bulbs to 15 W compact fluorescent bulbs. Which is the cheaper source of light? Assume that electricity costs \$0.10/kWh.

### Answer

Fluorescent bulb:

Cost of bulb: 15.00

Cost of electricity for 10,000 hours:

$$15 \times 10000 \frac{0.1}{1000} = 15.00$$

Total cost:  $15.00 + 15.00 = 30.00$  (dollars)

Incandescent bulb:

Number of bulbs needed for 10,000 hours:  $10000/1000 = 10$

Cost of bulbs:  $10 \times 0.50 = 5.00$

Cost of electricity:

$$60 \times 10000 \frac{0.1}{1000} = 60.00$$

Total cost:  $60.00 + 5.00 = 65.00$  (dollars)

Conclusion: Although an incandescent bulb is much cheaper, in the long run (10,000 hours), the fluorescent bulb will cost \$30.00, while the incandescent bulb will cost \$65.00.

## Questions

1. Roughly two billion CFLs will be sold in the U.S. this year, which represent 5 percent of the total light bulb sales. What are the total light bulb sales in the United States?
2. In the U.S. about one sixth of children are born having been exposed to mercury levels to a level that they are at risk for memory loss and learning disability. Let us suppose that there are 84 million children in the U.S. How many children are at risk of mercury poisoning?
3. According to the article, each CFL contains about five milligrams of mercury. Wal-Mart announced a goal of selling 100 million CFLs annually. How many grams of mercury is contained in 100 million CFLs?
4. The recycling rate for fluorescent bulbs in the U.S. is about 24 percent. Let us assume the recycling rate of 25 percent for Wal-Mart CFL. How many grams of mercury is not recycled?
5. What do you do if you accidentally break a CFL?

## Reflection

There is no costless solution to environmental protection, and all measures create their own sets of issues. After performing the above calculations, do you have a deeper appreciation of the environmental challenge we are facing? Are you more aware of the necessity of recycling programs? Write an essay to reflect your learning. You might visit the website of the Environmental Protection Agency at [www.energystar.gov](http://www.energystar.gov). You can also find a CFL recycling program in your area by visiting [www.lamprecycle.org](http://www.lamprecycle.org).