Middle School Activities

The content in this section was adapted from "Mercury in Schools and the Community: A National Issue." University of Wisconsin System Board of Regents, March 2002.

Region 7

Activity 1 – Mercury I.Q.

Handout to students to test their mercury I.Q.

1. What is mercury?
    a. A type of tree found in the rainforest
    b. An element on the periodic table (symbol: Hg)
    c. A liquid aliens like to put on their hamburgers

2. What is another common name for mercury?
    a. Quicksilver
    b. Space goo
    c. There are no other names for mercury

3. What can mercury be found in?
    a. Switches
    b. Thermostats
    c. Thermometers
    d. All of the above

4. Which animals are most likely to have elevated mercury levels in tissues?
    a. Large fish
    b. Snakes
    c. Birds that live in a rainforest

5. Mercury is used in:
    a. Dental fillings for cavities
    b. Fluorescent lamps
    c. Cars
    d. All of the above

6. Mercury is mined today in what countries? (Mark all that apply)
    a. U.S.
    b. Spain
    c. Mexico
    d. Russia

7. Some states or local governments have passed bans on the sales of:
    a. Mercury thermostats
    b. Mercury thermometers
    c. Fluorescent lights
    d. (a) and (b) above

8. Mercury is the only known metal that is liquid at 72 degrees: True or False

9. Mercury can be very dangerous: True or False

Answer Sheet for activity 1

1. b
2. a
3. d
4. a
5. d
6. b
7. d
8. True
9. True

Activity 2 - Case Study of Mercury Contamination in a School

Purpose

To create an awareness within students that mercury exposure in schools does occur and can cause health risks.

Objective

Students will demonstrate their understanding of mercury issues in schools by discussing a news story.

Materials

✓ Article from the Detroit Free Press, "Teacher placed on paid leave after toxic science experiment"

✓ Press release from the Agency for Toxic Substances and Disease Registry (ATSDR), "ATSDR and EPA Warn The Public About Continuing Patterns Of Elemental Mercury Exposure"

Procedure

Assign the above article and press release to be read prior to class. Assign different students to lead the discussion of any or all of the following questions (and/or questions that you develop for this activity). This involves preparing a brief introduction for the topic and facilitating discussion of the question among the other students.

Discussion Questions

? Why should we be concerned about mercury?

? What are some of the symptoms of exposure to mercury?

? Why are young children and fetuses more vulnerable to mercury exposure than adults?

? What are some of the different ways that we can be exposed to mercury?

? How does mercury move around in the environment?

? What would you advise your parents to do if they discovered a broken mercury thermometer in the house?
What would you do if you came across a jar of mercury in someone's garbage or in an abandoned lot?

? What dangers are associated with the use of mercury as folk medicine or for religious practices?

? What are some of the special properties of mercury that make it different from other materials?

? Do you think there is mercury in this school? Where?

? Do you think there is mercury in your home? Where?

? Why is it so hard to clean up mercury after it has spilled?

Article taken from Detroit Free Press:

"Teacher placed on paid leave after toxic science experiment"

December 4, 2001 1:56P.M.

GRAND LEDGE, Mich. (AP) --A middle school teacher is on paid leave while district officials investigate why he allowed students to touch mercury during an experiment.

Up to 27 sixth-grade science students at Hayes Middle School were directly exposed to the toxic liquid metal while doing a physical science experiment in teacher Paul Cherry's class last week, district spokesman Steve Krumm told the Lansing State Journal for a story Tuesday.

Officials in the Eaton County district about 10 miles west of Lansing became aware of the exposure Friday and brought in health officials to assess the health risks.

On Monday, Cherry's classroom was blocked off from use. Superintendent Marsha Wells issued a news release on the incident but refused to answer specific questions.

Cherry has declined comment.

Three Barry-Eaton District Health Department employees worked about 16 hours Friday and Saturday to test for mercury and advise school officials about what to do, said Jim Rutherford, Barry-Eaton director of the environmental health division.

Health officials also visited the homes of the teacher and students to make sure the mercury wasn't spread, he said. A few book bags and clothing items were collected. "All in all, it's a fairly contained situation," Rutherford said.

There were two bottles containing mercury in the classroom, each with less than two tablespoons of mercury, Rutherford said.

"Any amount of mercury can become very harmful if it is vaporized," he said.

High levels of mercury -- found in old glass thermometers and fluorescent lights – can cause kidney failure, central nervous system damage and even death.

Grand Ledge High School junior Alicia Arritt said Cherry let her class touch mercury five years ago in a sixth-grade science class at Grand Ledge's Beagle Middle School.

Cherry held the mercury and told the students then they could touch it if they wanted to, Alicia said. "He didn't make it seem dangerous at all," she said. Alicia didn't handle the mercury.

The district hired Marine Pollution Control, a Detroit-based environmental health consulting firm, to do the cleanup at Hayes. Mercury traces were found in the classroom and lockers of five students, according to the news release. Equipment and furniture are being replaced in the affected classroom.

Barry-Eaton District Health Department will write its report on the incident and provide copies for the Michigan Department of Community Health and Grand Ledge Public Schools, Rutherford said.

By Dec. 31, 2004, Michigan school districts must remove all instruments containing mercury that are handled by children, according to recent state law.

"This is great information to go out in the school system and tell people why we want mercury out of the schools system," Rutherford said. "It does happen and it will happen.

This can be found online at:
www.atsdr.cdc.gov/alerts/970626.html

For more information, contact:
Loretta Bush
ATSDR Office of Policy and External Affairs
(404) 639-0601
e-mail: lob3@cdc.gov

ATSDR and EPA Warn the Public about Continuing Patterns of Elemental Mercury Exposure

Elemental (or metallic) mercury is a hazardous chemical that can cause serious health problems. Children (especially very young children) and fetuses are most vulnerable. The Agency for Toxic Substances and Disease Registry (ATSDR), part of the U.S. Public Health Service, and the Environmental Protection Agency (EPA) are jointly issuing an alert to the general public. There is a continuing pattern of elemental mercury exposure in children and teenagers and in persons using certain folk medicines or participating in certain ethnic or religious practices.

ATSDR and EPA strongly advise against the use of uncontained elemental liquid mercury (that is, mercury not properly enclosed in glass as it is in thermometers) in homes, automobiles, day care centers, schools, offices, and other public buildings.

It is important for the general public to understand that either short-term or long term exposures to elemental mercury can lead to serious health problems. Human exposure to elemental mercury occurs primarily from breathing contaminated air. Other forms of mercury can be absorbed by drinking contaminated water, eating food (usually fish containing mercury), and from skin contact. At high levels, elemental mercury can effect the nervous system and may harm the developing fetus. Other forms of mercury can damage other organs. Even at low levels, elemental mercury can cause health problems.

Elemental mercury exposure can cause harm before symptoms become evident. Once released into the environment, mercury is very hard to clean up. If it is left unattended where exposures can occur, it can have dangerous effects on human health.

Incidents involving Schoolchildren

- In recent years, increasing numbers of elemental mercury spills and contamination involving schoolchildren have been reported.
- In August 1994, more than 500 students in Belle Glade, Florida, were contaminated with elemental mercury after three children found 4 jars (totaling 55 pounds) of mercury in an abandoned van. The local hazardous waste materials team decontaminated the children (removed contaminated clothing and washed the elemental mercury from their skin). More than 20 families had to be evacuated while their homes were decontaminated.
- In November 1994, college students at Florida Atlantic University in Boca Raton, Florida, removed elemental mercury from one of the school's laboratories. Students living in the dormitory were evacuated and housed in a local hotel while the dormitory was decontaminated.
- In June 1996, elemental mercury was taken from a middle school in St. Joseph, Missouri, and used in and outside of school by a group of teenagers. Approximately 200 children were tested for mercury exposure; one child was hospitalized and another five underwent outpatient treatment to remove the mercury from their systems; 20 other children had mildly elevated

mercury levels. Two homes and a car required extensive decontamination.

? In October 1996, a high school in Oskaloosa. Kansas and a convalescent home in Johnson County, Kansas, were contaminated with elemental mercury;52 students and an unknown number of residents of the home were tested. On the basis of ATSDR recommendations, the school was closed for a week until indoor air levels were safe. A month later, sampling at the school identified an increase in air mercury concentrations. ATSDR re-evaluated the school and did additional cleanup.

? In November 1996, ATSDR again assisted state health officials and EPA in evaluating contamination at a high school and a home in Dallas, Pennsylvania, near Wilkes-Barre. Four areas in the school had levels of elemental mercury contamination that required cleanup.

? In March 1997, a middle school student on his way to school found elemental mercury on the street in front of his home in Montgomery County, Pennsylvania. The student took the mercury to school and shared it with three to four classmates. Also, in March 1997 a broken mercury thermometer was discovered after school on the floor of a bathroom stall in the boys' bathroom. One thermometer was confirmed missing from the science department's inventory. The school was found to be clear of contamination with the exception of one science laboratory and the carpet in a classroom. Two homes required decontamination.

Schoolteachers, particularly science teachers, and administrators need to be aware of students' interest in mercury, especially elemental mercury, and take steps to ensure that children are aware of its dangers and that any mercury kept in school is safely and securely contained.

Incidents involving religious practices

Persons who use elemental mercury in ethnic folk medicine and for religious practices are at risk. Elemental mercury is sold under the name "azogue" in stores (sometimes called botanicas), which specialize in religious items used in Esperitismo (a spiritual belief system native to Puerto Rico), Santeria (a Cuban-based religion that venerates both African deities and Catholic saints), and voodoo.
The use of azogue in religious practices is recommended in some Hispanic communities by family members, spiritualists, card readers, and santeros. Typically, azogue is carried on one's person in a sealed pouch prepared by a spiritual leader or sprinkled in the home or automobile. Some botanica owners suggest mixing it in bath water or perfume and placing it in devotional candles.

General facts

The following are general facts about elemental mercury and its risks, as well as information about how people can protect themselves from exposure and resulting health effects.

What is mercury and how is it used?

Mercury occurs naturally in the environment in several forms. Elemental mercury is the liquid form used in thermometers. Mercury is also used in other common consumer products such as fluorescent light bulbs, barometers, medical equipment such as blood pressure measurement instruments, and mercury switches in children's sneakers that light up. This alert focuses on elemental mercury, which is the form of mercury that poses the greatest risk to human health in the home and school.

How could I be exposed to mercury?

In the previously described cases of contamination at school, children were unaware of the dangers involved in exposing themselves and their families to this deadly poison. Adults are also often unaware of the hazards associated with mercury; some have even brought it home from work for children to play with. Just one-half teaspoon of mercury spilled in the home can be dangerous.

Adults using certain folk medicines or participating in certain religious or ethnic practices may also expose themselves and their families to elemental mercury's effects. Because elemental mercury vaporizes into the air at room temperatures, it presents an immediate health risk to anyone spending a significant amount of time in a room where elemental mercury is sprinkled or spilled onto the floor, or where opened containers of elemental mercury are present. Very small amounts of elemental mercury (for example, a few drops) can raise air concentrations to levels that may be harmful to health.

How does mercury affect health?

At high levels, elemental mercury can cause effects on the nervous system and the developing fetus. Other forms of mercury can damage other organs. Even at low levels, elemental mercury can cause health problems. Mercury exposure can begin to cause harm before symptoms become evident. Once symptoms do arise, health problems related to elemental mercury poisoning can include tremors, changes in vision or hearing, insomnia, weakness, difficulty with memory, headache, irritability, shyness and nervousness, and a health condition called acrodynia. Acrodynia, which results from dermal exposures to elemental mercury of acute and/or intermediate duration, is characterized by itching, swelling, and flushing; pink-colored palms and soles of the feet; excessive perspiration; rashes; irritability; fretfulness; sleeplessness; joint pains and weakness. Children exposed to elemental mercury for long periods may have trouble learning in school. Exposure to mercury can result in communication and learning disabilities that may be irreversible. Pregnant women and their fetuses and women of childbearing age are especially vulnerable to the toxic effects of elemental mercury because it readily passes from the mother to the fetus. Mercury may accumulate in higher concentrations in the unborn baby than in the mother. Young children, who often play on the floor where metallic mercury may have been spilled, are particularly at risk for effects on the central nervous system. Mercury vapors are readily absorbed into the bloodstream from the lungs. Once in the lungs, the developing central nervous system of young children may be damaged.

Health effects can result from short-term or long-term exposure. The body gets rid of mercury through the urine and feces. Removal of this substance from the body can take up to several months after exposure. When mercury levels in the body are extremely high, "chelation" therapy is necessary. Chelation therapy is an unpleasant treatment that involves putting a chemical into the bloodstream; the chemical combines with the mercury to aid in its removal from the body. **Prevention is the key to avoiding poisoning in homes, schools, and families.**

What is mercury contamination and how can I prevent it?

Mercury contamination results from exposure through the air, water, food, soil, or direct contact. Exposure to elemental mercury occurs when it is not stored in a closed container. Contamination may include the spilling of elemental mercury on clothes, furniture, carpet, floors, walls, the natural environment, and even the human body. Elemental mercury and its vapors are extremely difficult to remove from such items as clothes, furniture, carpet, floors, and walls. The vapors will also accumulate in walls and other structures in contaminated rooms. The contamination can remain for months or years, posing a

risk to exposed individuals. The use of elemental mercury in a home or apartment not only poses a threat to persons currently residing in that structure, but also to those who subsequently occupy that dwelling and are unaware of the past mercury use.

Avoid using elemental mercury. Appropriate substitutes are available for nearly all uses of elemental mercury. Therefore, be sure you need to use it. If substitutes are not available, make arrangements to safely dispose of whatever elemental mercury you might have by calling your local poison control center. If you do need to use elemental mercury, make sure it is safely stored in a leak proof container. Keep it in a secure space (e.g., a locked closet) so that others cannot easily get it. Use of elemental mercury in a controlled environment helps to reduce the risk that contamination will occur.

Can I clean up mercury with a vacuum cleaner?

Never use a vacuum cleaner. Using a vacuum cleaner causes elemental mercury to vaporize in the air, creating greater health risks. It also ruins the vacuum cleaner.

Can electronic equipment collect mercury vapors?

Elemental mercury vapors can accumulate in electronic equipment, especially computers. When the computer is turned on, the mercury revaporizes. This cycle of elemental mercury collecting and vaporizing from computers has been seen in several incidents in schools. Mercury vapors are very dangerous and are virtually undetectable. Avoid breathing mercury dust, vapor, mist, or gas. Avoid contact with eyes, skin, and clothing. If you feel you have been exposed directly to elemental mercury, wash thoroughly after handling. Remove contaminated clothing and wash before reuse. If someone has breathed in mercury, provide as much clean air as possible.

What should I do to keep my home safe?

Care must be taken in handling and disposing of all items in the home that contain elemental mercury. Elemental mercury is used in a variety of household and industrial items including thermostats, fluorescent light bulbs, barometers, glass thermometers, and some blood pressure machines.

Example

If a thermometer breaks, remove children from the area. Clean up the bead of elemental mercury by carefully rolling it onto a sheet of paper or sucking it up with an eye dropper. After picking up the mercury, put it into a jar or airtight container. **Do not wash it down the drain or throw it outside.** The paper or eye dropper should also be bagged and disposed of properly according to guidance provided by environmental officials or your local health department. Try to ventilate the room to the outside and close off from the rest of the home. Use fans for a minimum of one hour to speed the ventilation. If larger amounts of elemental mercury are found (for example, a jar), make sure that the mercury is in an airtight container and call your local health department for instructions in how to safety dispose of it. If a larger amount is spilled, leave the area and contact your local health department and fire authorities. Do not simply throw it away, but instead seek professional guidance from environmental officials or your local health department.

<u>Important Telephone Numbers</u>

? Agency for Toxic Substances and Disease Registry (ATSDR) Emergency Response
? Hotline (24 hours): (404) 639-0615
? National Response Center 1-800-424-8802
? Superfund Information Hotline: 1-800-424-9346
? You may also call your local health department

Activity 3 - Mercury in the Food Chain

Purpose
This activity will help the students reinforce their understanding of food webs while gaining a new understanding of bioaccumulation.

Objectives:
Students will:

1) Display a graphic understanding of an aquatic food web for a specific local body of water
2) Demonstrate an understanding of bioaccumulation

Materials:

- ✓ A map of your state showing waterways (a state highway map will usually work), paper and something to draw with
- ✓ Copies of "Example from Florida aquatic food web and mercury cycle" and information provided in ***Mercury in the Environment*** section of this curriculum package
- ✓ If you choose the teacher lead option you will need the following materials
  - 10 very small (1-2 oz.) cups

    (clear containers are the best, but use what you have).
  - 5 small containers (4 –5 oz.)
  - 3 medium containers (around 8 oz.)
  - 1 clear container (large to hold around 7-8 cups)
  - Glitter (3 colors) or small beads (3 colors) or something similar that is very small and can be found in 3 distinct colors

Procedure:

1. Select a body of water or a number of water systems in your state.
2. Divide the class into study groups. Assign each group a lake, river, bay, coastal area, etc. Each group should then create a food web for their study site. Include as many of the components that they can find. You may use the Florida example on page 12 as an example.
3. Select either student self-discovery or teacher lead and follow accordingly.
4. Students should share their findings.

Select one of the two options: student self-discovery or teacher lead

Student self-discovery: Present each group the following scenario – the water they are in charge of has shown signs of mercury contamination. As scientists they are to demonstrate to the public what "bioaccumulation" is and why we have to be concerned about it.

1. Allow them to use a variety of materials
2. Give each group 5 minutes for their demonstration.
3. If you wish, you can set up a town board to judge who did the best job of demonstrating the issue.

Teacher lead:
You will need to gather the following materials: (clear containers are the best, but use what you have).

- 10 very small (1-2 oz.) cups
- 5 small containers (4 –5 oz)
- 3 medium containers (around 8 oz)
- 1 clear container (large to hold around 7-8 cups)
- Glitter (3 colors) or small beads (3 colors) or something similar that is very small and can be found in 3 distinct colors.

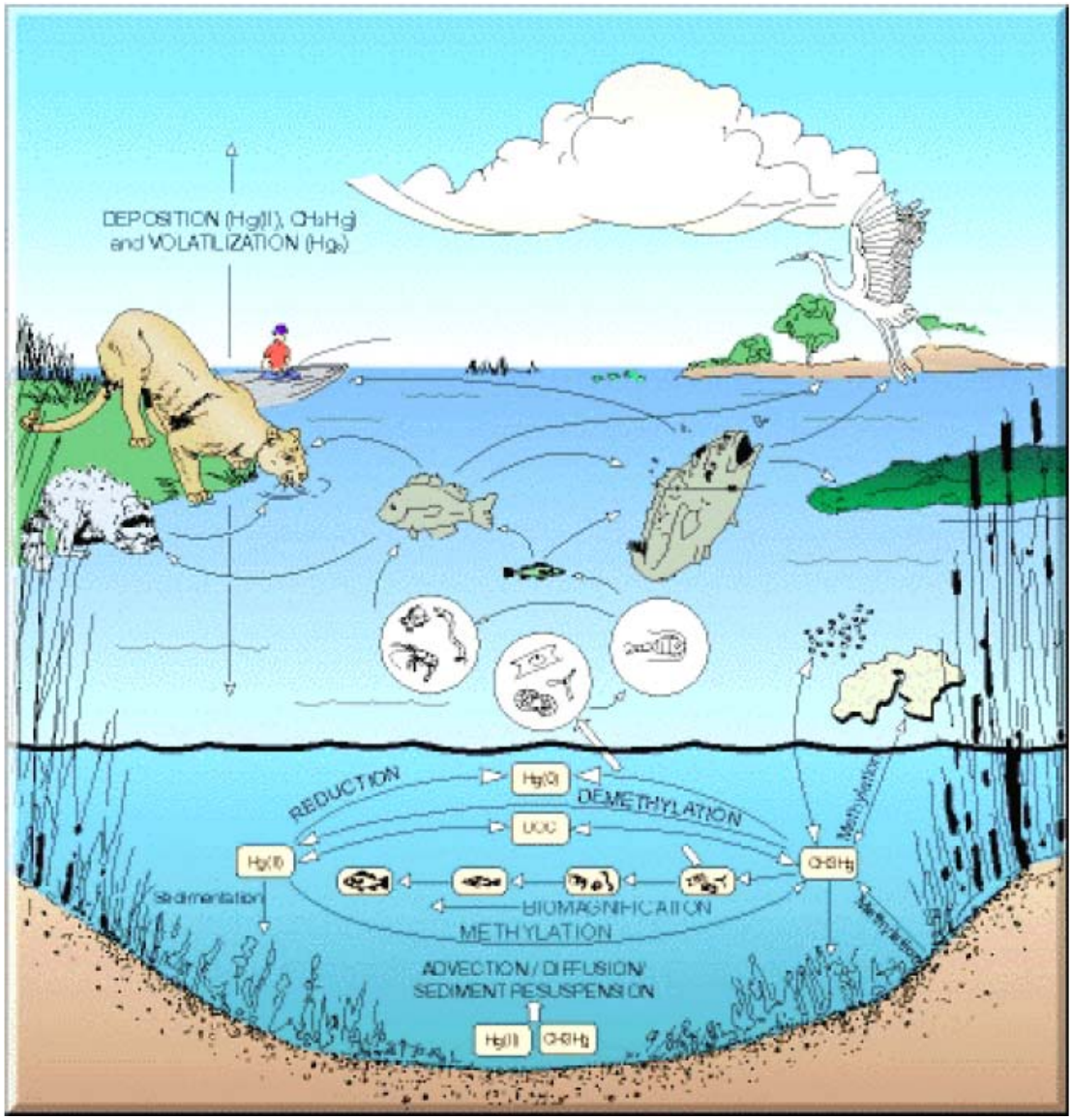
1. Fill each container to one-third full with water.
2. Now, representing mercury, you will put a pinch of one color of glitter in each of the 10 very small (1-2 oz.) cups, another color in the 5 small containers (4 –5 oz.), and the third color in the 3 medium containers (8 oz.)

Using one of the food chains the students developed, have the students label the 10 very small ones as the micro-organisms, the 5 small ones as the animal that eats the microorganisms (small fish, insects, etc.), the medium would be the animal that eats the small ones and the clear container will represent a top predator.

Now have the students help you with the demonstration and put the food chain and bioaccumulation into action. First the 10 very small containers (they are being eaten by the primary consumer) are poured into the small containers. Some of the glitter might stay in each container as you pour. That is OK; it represents the mercury that is excreted by the animal (not 100 percent of the mercury accumulates). Now the small containers will be eaten by the medium or secondary consumer. And finally the medium are eaten by the top predator (tertiary consumer).

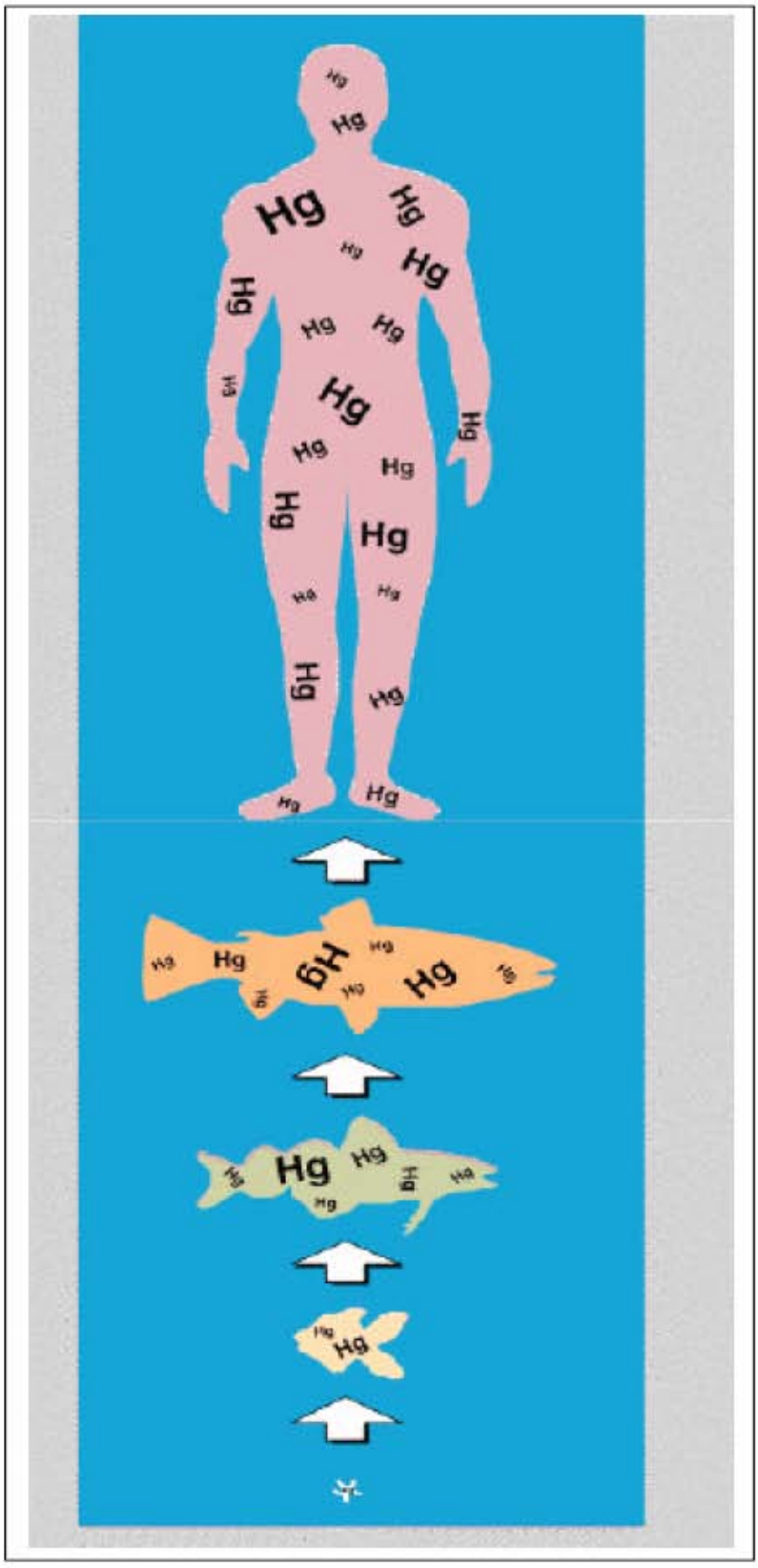
Discuss what just happened, with special emphasis on the glitter. How much of the mercury was accumulated by the top predator?

Regardless of whether you did the student self-discovery or the teacher lead option, now hand out the **Bioaccumulation in humans** chart (on page 13) and discuss what they have learned through the activity.



Example from Florida aquatic food web and mercury cycle

Bioaccumlation in humans



Activity 4 - School Mercury Audit

Now it is time to conduct a mercury school audit!!

Purpose

Schools are places where mercury and children might come together. They are also places where we can model appropriate health and environmental protection behaviors. Last, schools can also be catalysts for reducing mercury in the homes of students (and staff).

Objectives

• Involve students in a meaningful, real life opportunity to do something about an environmental problem at their school.
• Reduce or eliminate opportunities for students and staff to come in contact with mercury.
• Prevent the release of mercury into the environment from mercury or mercury-containing devices at school, by properly disposing of Hg.

Materials

✓ "Mercury at School: Where to Look And What to Look For": Information about conducting a school mercury audit.
✓ Copies of Mercury Audit Checklist (one per team)

Note to Teachers:
This activity assumes that you and your school's administration are open to removing and replacing mercury and mercury-containing devices from your school. Please proceed with your students accordingly.

Procedure

• Obtain approval from your principal.
• Discuss the audit with your school's engineering and/or janitorial staff.
• Introduce the topic of mercury to the class, using any or all of the materials included in the *Focus on Mercury* section of this package (pages 1-11).
• Hand out copies of "Mercury at School: Where to Look and What To Look For" to students and ask them to review it ahead of time.
• Divide your school or classroom up and assign research teams to cover specific areas. (Obtaining the building blueprint would be very helpful but is not necessary.)
• Now have the students develop an audit "plan," i.e. what will they look for, who will they talk to, and what will they ask. They might wish to map the locations of mercury or suspected locations.
• Conduct the audit using the mercury audit form or a form designed by the students.
• Have students discuss the results with the principal, science teachers, school nurse, and engineering and/or janitorial staff. Make recommendations for safely recycling mercury and replacing mercury-containing products or equipment, as appropriate.

Mercury at School: Where to Look and What to Look For

Science, Chemistry, Physics and Biology Classrooms

Check for: pure mercury, mercury compounds, thermometers, barometers, or other devices that might contain mercury

Why? Mercury and mercury compounds have been used in various experiments. They might or might not be used now, but they might still be in the cabinet or chemical closet. Mercury thermometers, barometers, or other mercury-containing devices might be used in science, chemistry, biology and physics classes.

Alternatives: Other chemicals can be used in class experiments to illustrate science or chemistry principles. Alcohol or electronic thermometers are readily available and sufficiently accurate.

Whom to Talk to: Chemistry and other science teachers

Questions to Ask:

(1) Are mercury or mercury compounds currently used in class?
(2) If they are being used, could other chemicals replace them?
(3) Do you know if these have been used in the past in science classes in this school?
(4) Are these being stored in a closet, cabinet or elsewhere?
(5) How many mercury thermometers or other mercury devices are in the classroom?

(6) Have you ever experienced a spill of mercury or a broken mercury thermometer in your classroom?
(7) Is a mercury spill kit readily available if a spill occurs?
(8) Are you familiar with the proper spill control procedures for mercury?

Possible Actions: Make sure any mercury, mercury compounds, or thermometers are in non-breakable containers. These should all be collected by school engineering and/or janitorial staff and held in a safe, secured area prior to recycling them.

Your school should not wait for mercury thermometers to break before replacing them with non-mercury alternatives. If a barometer is to be retained, make sure it is protected by a Plexiglas or similar enclosure. If mercury thermometers or barometers will not be replaced at this time, obtain spill kits for the science classrooms and storage rooms. Make sure that at least several staff people are trained in proper spill control procedures.

Mercury at School: Where to Look and What to Look For

Nurse's Office

Check for: thermometers, blood pressure measuring devices (sphygmomanometers), nasal spray and contact lens solution

Why? Mercury thermometers are used to check for fever. Sphygmomanometers can contain up to several pounds of mercury. Nasal spray and contact lens solution might contain thimerosal (an ingredient that has mercury in it), phenyl mercuric acetate or phenyl mercuric nitrate.

Alternatives: Alcohol or electronic thermometers are readily available. Aneroid blood pressure devices are just as effective as the mercury versions. Many brands of nasal spray and contact lens solution do not contain mercury; however, the labels do not always indicate which ones are mercury free.

Whom to Talk to: School Nurse

Questions to Ask:

(1) How many mercury thermometers are in the nurse's office?
(2) Have you ever experienced a broken mercury thermometer?
(3) Is a mercury spill kit readily available, if a spill occurs?
(4) Are you familiar with the proper spill control procedures for mercury?
(5) Do you use a sphygmomanometer? If yes, have you considered replacing it with an aneroid blood pressure device that does not contain mercury?

(6) Do you stock nasal spray or contact lens solution? If yes, have you contacted the manufacturer to make sure they do not contain mercury?

Possible Actions:

Make sure mercury thermometers are in non-breakable containers.

These should all be collected by school engineering or janitorial staff and held in a safe, secured area prior to recycling them.

Do not wait for mercury thermometers to break before replacing them with alcohol or electronic alternatives.

Replace sphygmomanometers with aneroid blood pressure devices.

If mercury thermometers or sphygmomanometers will not be replaced at this time, obtain a spill kit for the nurse's office. Make sure that the nurse(s) are trained in proper spill control procedures.

Use up existing stock of nasal spray or contact lens solution containing mercury and then purchase mercury-free alternatives.

Mercury at School: Where to Look and What to Look For

Electrical And Heating Equipment

Check for: thermostats, "silent" light switches and recycling of fluorescent light bulbs

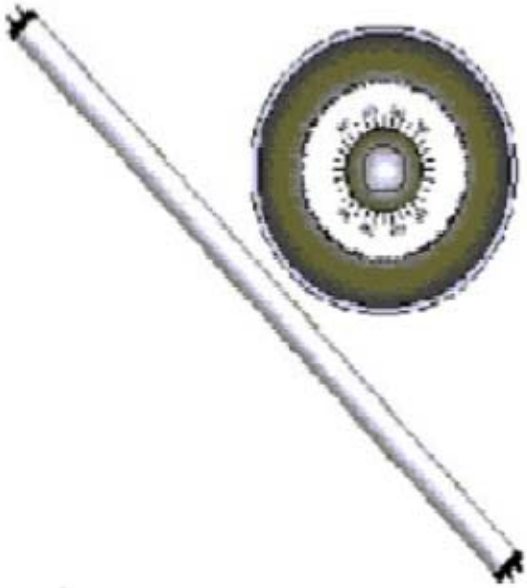
Why? Thermostats are used to control the temperature in buildings. Approximately 75 percent of thermostats in use today contain mercury. Mercury light switches on walls (also known as "silent" switches) were manufactured prior to 1991 and still exist in many buildings. Each fluorescent tube in overhead lighting fixtures contains a minute amount of mercury. However, your school probably uses a large number of these fluorescent bulbs throughout the building, so the total amount of mercury can be significant.

Alternatives: Electronic thermostats and non-mercury switches are widely available. Fluorescent bulbs should be recycled, rather than thrown out.

Whom to Talk to: School engineering or janitorial staff

Questions to Ask:

(1) How many thermostats and "silent" light switches are there in your school building?
(2) How many of these contain mercury?
(3) How are used fluorescent bulbs managed? Are they recycled or thrown out in the trash?
(4) If they are recycled, how and where are they stored before they are taken from the building for recycling? How are they protected to avoid breaking them?



Possible Actions:

Place stickers (designed by the students) on any mercury thermostats or silent switches that indicate:

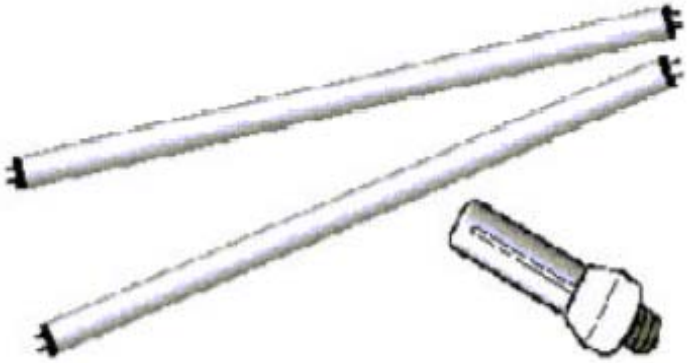
(1) This device contains mercury.
(2) When this device is disposed of, the mercury should be recycled.
(3) When purchasing a replacement, a mercury-free model should be chosen.

Notify the purchasing department to try to get mercury-free thermostats or light switches when purchasing replacements. Many HVAC contractors will recycle mercury thermostats.

Your school should recycle used fluorescent bulbs by replacing them in their original box in a safe, secure storage area until they are picked up by a recycling contractor.

Mercury at School: Where to Look and What to Look For

Fluorescent & High-Intensity Discharge (HID) Lamps



Which Lamps Contain Mercury?

- fluorescent lamps
- mercury vapor lamps
- metal halide lamps
- high-pressure sodium lamps
- neon lamps

Why Use Fluorescent and HID Lighting?

Fluorescent and HID lighting is an excellent business and environmental choice because it uses less than 50 percent of the electricity required by incandescent lighting. The U.S. Environmental Protection Agency encourages homes, schools, and businesses to "change a light," replacing incandescent bulbs with compact fluorescent bulbs.

Nonetheless, used fluorescent, compact fluorescent, and HID lamps must be managed properly because they contain mercury.

How Do I Dispose of the Lamps?

- Store lamps in an area and in a way that will prevent them from breaking, such as in their original shipping boxes or boxes supplied by lamp recyclers.
- Mark the lamp storage area with the words "Fluorescent lamps for recycling."
- Do not break or crush lamps, because mercury might be released.
- If lamps are accidentally broken, store them in a sealed container. Scoop up spilled powder and add it to the sealed container.
- Take lamps to a consolidation site* or arrange with a lamp transporter to pick them up. Contact your city, county or state environmental office or solid waste office for services available in your area. To protect yourself from future liability, save the invoices that track your used lamps and include the following information:
  - the date of shipment
  - the number of lamps
  - the location from where the lamps are being shipped
  - the destination of the shipment

**These services might not be available in your area.*

Mercury Audit: Assessment Checklist for Schools

Science, Chemistry, Physics, Biology Rooms					
Item	No	Yes	Use?	How Many/ How Much?	Location?
Elemental Mercury					
Mercury Thermometers					
Mercury Barometers					
Mercury Vacuum Gauges					
Hg Spectral Tubes					
Mercury Molecular Motion Device					
Mercury Sling Psychomotor					
Mercury Compounds					
Mercury Oxide					
Mercury (II) chloride					
Mercury (II) sulfate					
Mercury nitrate					
Mercury iodine					
Zenker's Solution					
Other Mercury Materials					

Nurse's Office/ Medical					
Item	No	Yes	Use?	How Many/ How Much?	Location?
Mercury Fever Thermometers					
Sphygmomanometers (Blood Pressure Devices)- with silver liquid					
Nasal Spray					
Contact lens solution					

Facilities					
Item	No	Yes	Use?	How Many/ How Much?	Location?
Fluorescent Lamps					
Mercury Thermostats					
Mercury Vapor Lamps, Metal Halide Lamps High-Pressure Vapor Sodium Lamps					
Mercury Gauges					

Mercury-containing (“Silent”) Light Switches					
Mercury Float Control Switches (e.g. on Sump Pumps)					
Flow Meters with Mercury Switches					
Other equipment with mercury switches (e.g. flame sensors, fire alarms, safety valves)					
Older fungicides and pesticides (prior to 1991)					

Other					
Item	No	Yes	Use?	How Many/ How Much?	Location?
Mercury Cooking Thermometer					
True Vermilion Paint (contains mercuric sulfide)					
Cadmium Vermilion Red					
Mercury Oxide/Mercury Zinc Batteries (old alkaline type, prior to 1996 and button batteries)					

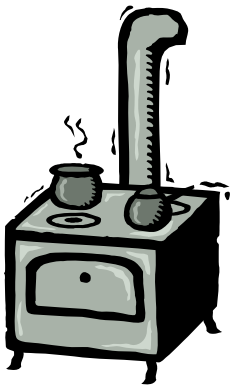
This form was borrowed from “Mercury in Schools & Communities,” Northeast Waste Management Officials’ Association (NEWMOA).
http://www.newmoa.org/Newmoa/htdocs/prevention/mercury/schools/checklist.cfm

Household Mercury

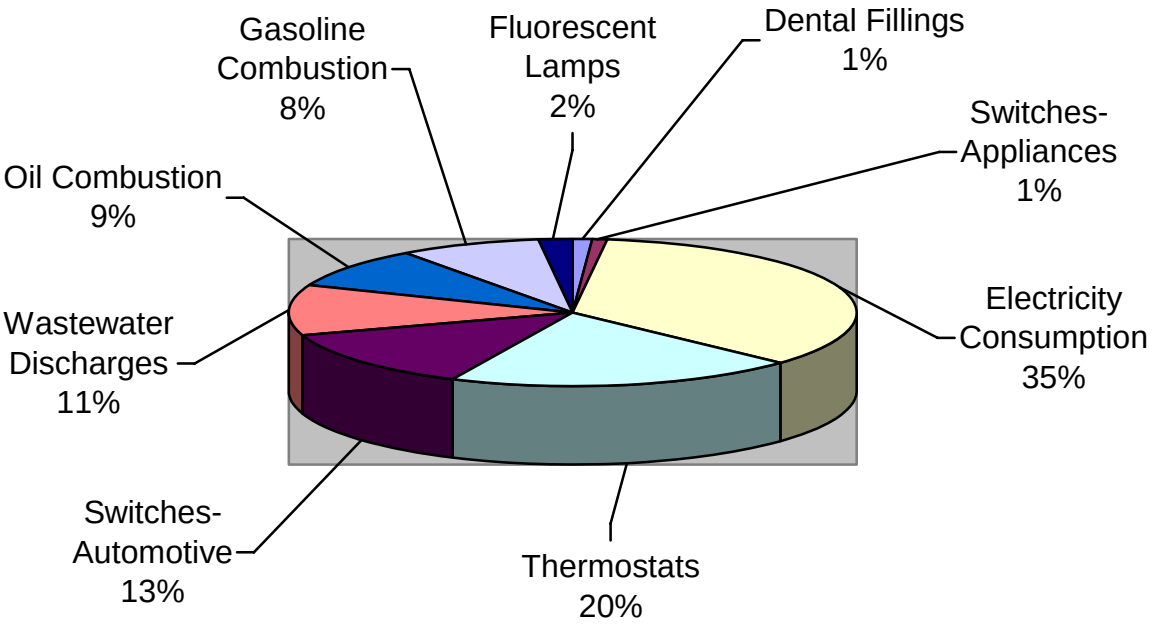
The following information illustrates how the average household contributes to the use and release of mercury to the environment. The idea is to provide a sense of how our daily activities, as well as devices and products in our homes, contribute to the overall picture of mercury release and use.

Charts are provided to show percentages of where mercury is most likely found in homes, “Presence/Use of Mercury in Households,” and what contributes most to the release of mercury, “Annual Mercury Releases from Households.” Mercury “releases” are defined very broadly and include air emissions, discharges to streams, lakes or sewers, and placement in landfills. The following types of uses or releases from households have been documented:

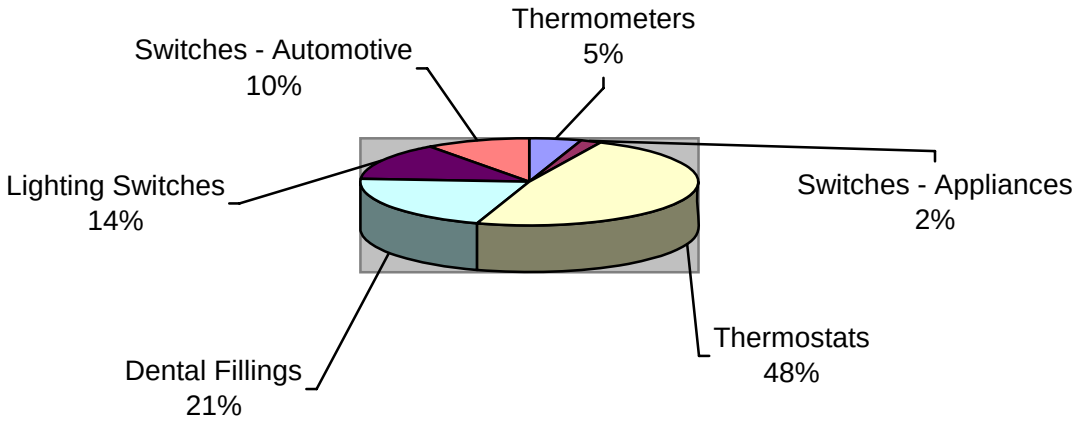
- coal combustion to produce electricity
- fluorescent lamps
- gasoline combustion in motor vehicles
- heating oil combustion
- appliance switches (chest freezers, washing machines)
- automotive switches
- thermostats
- dental fillings
- wastewater discharged to sewers
- button batteries
- gas-pilot ranges
- light switches
- thermometers



Annual Mercury Releases from Households



Presence/Use of Mercury in Households



Adopted from "Mercury Source Sector Assessment for the Greater Milwaukee Area" by the Pollution Prevention Partnership and Milwaukee Metropolitan Sewage District. 1997

Activity 5 - Hunt for Mercury At Home

Purpose
Students will expand their school efforts by looking at where mercury occurs in their homes.

Objectives
• Involve students in a meaningful, real-life opportunity to do something about an environmental problem at home.

• Reduce or eliminate opportunities for students and their families to come in contact with mercury.

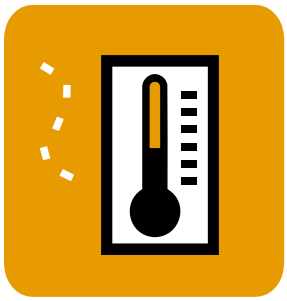
• Prevent the release of mercury into the environment from mercury or mercury-containing devices at home.

• Students will be able to analyze and then determine the level of threat of mercury in their homes.

Materials
✓ "Hunt for Mercury at Home," information for conducting a home mercury audit

✓ Sample letter to the parents

✓ "Hunt for Mercury at Home – Inventory Results" form



Procedure

• If appropriate, get the permission of your principal and then inform your parent organization.

• Introduce the topic of mercury to the class, using any or all of the materials included in the *Focus on Mercury* section of this package (Pages 1-11). Consider doing one or more of the other mercury related activities first.

• Try to find out the local contacts for household hazardous waste collection and add these to the bottom of the third page of "Hunt for Mercury at Home." The sewage treatment plant and department of public works are good places to find out if there is a household hazardous waste collection program in your area.

• Hand out copies of "Hunt for Mercury at Home" to students and allow them 3-7 days to complete the exercise.

• Have the students develop their own or use the sample letter provided to send home to each family.

• Make sure that students understand that they need to discuss this activity with their families before they do it and that it works best if they get help from family members.

• Have students compare their results and discuss safe ways of addressing the mercury in their homes.

Mercury University

Dear Parent,

One topic being covered at school is mercury. Mercury is an element that occurs naturally in the earth's surface. It can be found in many household products and products at school. Mercury presents an environmental threat because it can accumulate in animals and people and can be toxic. Its toxicity can endanger living organisms and can produce adverse health effects in people, such as headache, weakness, memory loss, and nervousness, among others. Mercury poisoning is possible just by breathing mercury vapors, which are invisible.

There are many efforts across the nation to educate people about mercury, its risks, and how to dispose of it. Mercury can be found in common household items such as thermometers, thermostats, fluorescent lamps, and certain types of appliance switches. An important thing to know is that the primary concerns with many of these mercury-containing products are how you dispose of them and what to do if they break. Simply having them in your home is harmless unless the devices break or are disposed of improperly. You do not need to throw out all the mercury-containing products that you find. Any device that contains mercury needs to be recycled properly and cannot be thrown in the trash. Try to find a household hazardous waste collection, or contact the sewage treatment plant or department of public works. When it is time to replace a mercury-containing product, use a mercury-free alternative. There are safe, dependable, and easy to use alternatives for all mercury-containing devices used in your home.

Your child has studied mercury at school and its effects on human health and the environment and has been given an information packet titled, "Hunt for Mercury at Home," along with an "Inventory Results" sheet. Please go through this with your child and fill out the "Inventory Results" sheet. Do not be alarmed if you come up with many objects in your home that contain mercury. The purpose of this is to make you aware of them and what to do with them. When it comes time to replace them, remember that buying smart is a great way to prevent pollution.

Thank you

Hunt For Mercury At Home

Information and Checklist to Help You Inventory the Mercury in Your Home and Learn about Safe Disposal Options and Mercury-Free Products

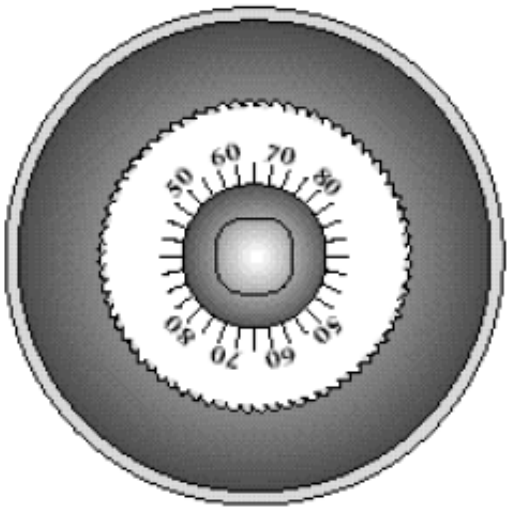
This guide provides a list of what to look for, what to do about mercury-containing products if you find them and what mercury-free substitutes are available.

Before getting started, share information about mercury with your family and let them know why you are searching for it in your home. Family members might be able to help you identify products that contain mercury and help you decide what to do about them.

Remember, the primary concern with many of these mercury-containing products is how you dispose of them. Using them safely in your home does not pose a problem unless the products break. You do not need to throw out all the mercury-containing products that you find.

A good example is thermostats. Many of you will find thermostats with mercury in your homes. These are designed to last a long time and are not a hazard to you and your family unless they break and spill the mercury. The best approach is to let your parents know that different types of thermostats are available and, if they replace the one they have now, they should install a mercury-free thermostat and properly recycle the old one.

This guide provides advice for what to do about each of the mercury-containing products that you might find in your home. Make sure to consider



common sense, recycling, safety and pollution prevention before taking action. You can also use this guide to help you and your family buy products that do not contain mercury. If you are careful about not buying mercury-containing thermometers, toys, thermostats, etc., you won't have to worry about mercury in your home in the future. Buying smart is a great way to prevent pollution!

Hunt For Mercury At Home

Product	Description	What To Do	Mercury-Free Alternative
Thermometers	Silver liquid in tube	Bring to Household Hazardous Waste Facility	Alcohol or digital thermometer
Thermostats	All non-electronic models	When it needs replacing, recycle	Electronic “set back” models can help save on energy bills
Fluorescent lights	Light bulbs in the form of long or curved tubes	Continue to use these, however, recycle them at the Household Hazardous Waste Facility	None, although some newer bulbs have less mercury than others
Old Alkaline Batteries	Bought before 1990. Check expiration date	Bring to Household Hazardous Waste Facility	Rechargeable batteries
Mercurochrome	An old time antiseptic for cuts and scraps	Bring to Household Hazardous Waste Facility	New antiseptics do not contain mercury
Maze Toys	Contain blob mercury	Bring to Household Hazardous Waste Facility	Mercury-free games
Shoes that Light Up or Make Noise	Bought between 1991 and 1994	Bring to Household Hazardous Waste Facility	Sneakers that don’t light up

Hunt For Mercury At Home

Product	**Description**	**What To Do**	**Mercury-Free Alternative**
Chemistry Sets	Might contain mercury compounds	Bring mercury or mercury compounds to Household Hazardous Waste Facility	Other mercury-free toys
Vials or Jars of Mercury, Sometimes on Necklaces	Small containers of mercury used for ceremonial purposes. Might be found in basements or garages.	Bring to Household Hazardous Waste Facility	None

Nearest Household Hazardous Waste Collection Facility:

Person to Call to Find Out About Household Hazardous Waste Collection in Your Community:

Hunt For Mercury At Home

Mercury Thermometers

Some fever thermometers contain mercury and should not be thrown in the trash. A typical fever thermometer contains about 0.5 grams of mercury.

Many thermometers used to measure air and water temperature also contain mercury, and they are used by homeowners, businesses, institutions, and anglers. When these thermometers break outdoors, the mercury from them is difficult to capture.

Alcohol or digital thermometers are as accurate as mercury thermometers for most applications. They are mercury-free, so no mercury will be released if they break or when they are thrown away. Digital thermometers last longer because they do not break. Consequently, they cost less in the long run.

Change to alcohol or digital thermometers whenever feasible. In the meantime, save old or broken mercury thermometers in a closed container. If a thermometer breaks, pick up all the mercury you can and add it to the container. Use two pieces of paper or two razor blades to scoop it up from a smooth surface. Use an eyedropper to pick up pieces of mercury from the floor or the ground. Place all cleanup tools in the closed container for disposal with the mercury. Mercury spill kits are available from safety equipment supply companies for larger mercury spills. Homeowners can use local household hazardous waste collection programs* for broken thermometers.

Mercury-Containing Thermostats

Mercury-containing tilt switches have been used in thermostats for more than 40 years. They provide accurate and reliable temperature control, require little or no maintenance, and do not require a power source. However, each switch contains approximately 3 grams of mercury.

Mercury-free thermostats are available. Electronic thermostats, for example, provide many of the same features as mercury thermostats and can be programmed to lower room temperatures at pre-set times. This results in fuel cost savings and environmental benefits from burning less fuel.

Contact your heating, ventilating, and air conditioning (HVAC) wholesaler. Thermostat manufacturers provide a special container for thermostats to each participating HVAC wholesaler. **DO NOT REMOVE THE SWITCHES FROM YOUR THERMOSTATS.** The wholesaler consolidates thermostats from heating contractors and mails them intact to the manufacturer.

*These services might not be available in your area

Mercury in Fluorescent Lights and the Environmental Impacts

The Use of Mercury in Efficient Electric Lamps - An Update

Heightened concern about mercury buildup in the environment has led to several recent legislative or regulatory actions targeted at all mercury-containing products. The general objective is to reduce or remove the mercury content of products.

Fluorescent Lamps

All efficient fluorescent lamps contain mercury. Fundamentally, these lamps are a discharge in mercury vapor. When excited, the mercury vapor discharge is an extremely efficient source of ultraviolet radiation; this is converted to visible light by the phosphor powder that coats the interior walls of the lamp.

HID Lamps

For the high-pressure sodium and metal halide lamps, mercury is used to initiate and maintain the discharge. Once started, the light output generated by the sodium, or by the metal halides, dominates the discharge.

Mercury-free developments

Mercury-free fluorescent discharges are available using Xenon. The efficiency is approximately 30 percent of a normal mercury based fluorescent lamp, and therefore this technology is environmentally counterproductive for general lighting applications. Despite continuous research by the private sector, government research labs, and academia, no viable replacement has been discovered for mercury in general purpose fluorescent lamps. The search continues. There are better prospects for mercury-free HID lamps, whereas metal halide lamps without mercury present a greater challenge. The high-pressure sulfur lamp is fundamentally mercury-free but is unstable and requires forced cooling.

Disposal

The EPA mercury report to the U.S. Congress in 1997 identified combustion sources (coal-fired utilities, waste incineration and boilers) as the three major sources of man-made mercury emissions in the United States. Together they represent 87 percent of the total. By contrast, lamp disposal represented less than 1 percent each for lamp breakage and lamp recycling. It is ironic that the use of efficient mercury containing lamps is the No. 1 choice for reducing power demand and thereby influencing utility emissions. Lamp disposal by incineration with other municipal wastes is a relatively recent phenomenon in some states. This represents the riskiest form of disposal with less than 90 percent mercury emission into the atmosphere where no controls exist on the incinerator. Recycling large quantities of lamps, where they are shipped intact to the recycling location, represents one of the lowest environmental emissions and the least legal liability arising from the U.S. Superfund legislation.

** Information taken from OSRAM SYLVANIA's web site, the North American division of OSRAM GmbH*

Activity 6 - Trade-offs

Purpose

One way to reduce mercury pollution from coal-burning electrical plants is to use less electricity. Fluorescent light bulbs use much less energy than incandescent light bulbs, but most fluorescent bulbs contain tiny amounts of mercury. What makes sense ecologically?

Objective

Evaluate the pros and cons of two alternative technologies.

Learn how to organize data and determine the mathematical relationships needed to solve a problem.

Coherently present the results of calculations to support a recommended choice or alternative.

Materials

- ✓ Handout titled “Trade-Offs: Your Lights, Your Environment and your Checkbook”
- ✓ Trade-offs: question sheet and answer sheet

Procedure

- This activity can be done as homework, or as an individual or group assignment.
- Make copies and distribute “Trade-Offs: Your Lights, Your Environment and Your Checkbook,” and the “Questions” sheet to the students and ask them to prepare answers and justifications for all questions.

Vs.

Fluorescent Bulbs (Containing mercury)

Incandescent bulb

Trade-offs

"Trade-Offs: Your Lights, Your Environment and Your Checkbook"
Incandescent vs. Compact Fluorescent Bulbs-
Energy Use, Mercury Emissions and Cost

The largest source of mercury to the environment is coal-burning electric power plants. There is a very small amount of mercury in the coal that is burned to produce electricity. However, because vast amounts of coal are burned, the amount of mercury released up the smokestacks is very significant.

One of the largest uses of the electricity produced by these power plants is for lighting homes, buildings and streets. Can the choice of light bulbs in our homes make a difference in terms of the amount of electricity used, the amount of mercury released and the amount that we pay for electricity? Let's figure it out.

	Incandescent Bulb	Compact Fluorescent Bulb
Energy Requirement	60 watts	15 watts
Light Output	870 lumens	925 lumens
Average Life	1,000 hours	10,000 hours
Purchase Price	$1.79 for 4 bulbs	$2.75 each

Cost of electricity from the power plant: $0.07 per kilowatt-hour
Pounds of mercury released per kilowatt-hour of energy used=
3.69E-08 (= 0.0000000369)

Keep in Mind-

1 kilowatt =1,000 watts
A lumen is a measure of brightness
A kilowatt-hour is a measure of total energy used over a period of time
1 pound = 454 grams
It takes 10 Incandescent bulbs to last as long as 1 compact fluorescent bulb

Equations to Use:

1. Efficiency = light output ÷ energy requirement

2. Amount of mercury released = hours of use x energy requirement x pounds of mercury released per kilowatt-hour of energy x 454 grams/pound of mercury ÷ 1000 watts/kilowatt

3. Electricity cost = Hours of use x energy requirement x cost of electricity ÷1000 watts/kilowatt

Trade-offs

Questions

1. Which type of light bulb - incandescent or compact fluorescent - is more efficient? Why?
2. After 10,000 hours of use, how much mercury (in grams) is released to the environment from the use of each of these two types of light bulbs?
3. After 10,000 hours of use, what are the total costs, including purchase price and electricity, for each type of light bulb?
4. Which type of bulb would you recommend? Why?

Optional

5. Make an educated guess as to how many light bulbs are in use in your community. Based on this estimate, design a study to determine the differences in cost and in mercury released if all those bulbs were either incandescent or compact fluorescent.

Trade-offs

Answers

Which type of light bulb - incandescent or compact fluorescent - is more efficient? Why?

Efficiency, in this case, is measured by light output per amount of energy used. For the compact fluorescent bulb, this is 925 lumens/15 watts = 61.67. For the incandescent bulb, this is 870 lumens/60 watts = 14.5. Thus, the fluorescent bulb is 4.25 times more efficient.

After 10,000 hours of use, how much mercury is released to the environment from using each of these two types of bulbs?

The amount of mercury released from using the compact fluorescent bulb is as follows:

10,000 hours X 15 watts X .0000000369 pounds per kilowatt-hour X 454 grams per pound ÷ 1,000 watts per kilowatt = .0025 grams.

The equation for the incandescent bulb is the same, except that 60 watts is substituted for 15 watts. Thus, the amount of mercury released is 4 times greater for the incandescent bulb, or .01 grams.

Note: A compact fluorescent bulb contains approximately 4mg (0.004g) of mercury, which is also released to the environment if the bulb is not properly recycled.

After 10,000 hours of use, what are the total costs, including purchase price and electricity, for each type of light bulb?

Purchase price-

Compact fluorescent - $2.75

Incandescent - $1.79/4 X 10,000/1,000 = $4.48

Electricity cost-

Compact fluorescent

10,000 hours X 15 watts X $.07 per kilowatt-hour ÷ 1,000 watts per kilowatt = $10.50

Incandescent

10,000 hours X 60 watts X $.07 per kilowatt-hour ÷ 1,000 watts per kilowatt = $42.00

Total cost-

Compact fluorescent

$2.75 (purchase) + $10.50 (electricity) = $13.25

Incandescent

$4.48 (purchase) + $42.00 (electricity) = $46.48

Thus, the incandescent bulb is three and a half times more expensive.

Which type of bulb would you recommend?

Consider efficiency (compact fluorescent is 4.25 times more efficient), amount of mercury released (4 times less for compact fluorescent if the compact fluorescent bulb is properly recycled) and total cost (three and a half times less for compact fluorescent).

Study design to determine the differences in cost and in mercury released for the community if all those bulbs were either incandescent or compact fluorescent**.**

The study design should include identification of the following steps:

- estimates of the number of bulbs used in lighting homes, streets and businesses
- assumptions about the frequency of bulb replacement
- determination of the total energy used by the community to light the bulbs
- application of the mercury released per kilowatt factor to determine total mercury releases
- determination of purchase and electricity costs