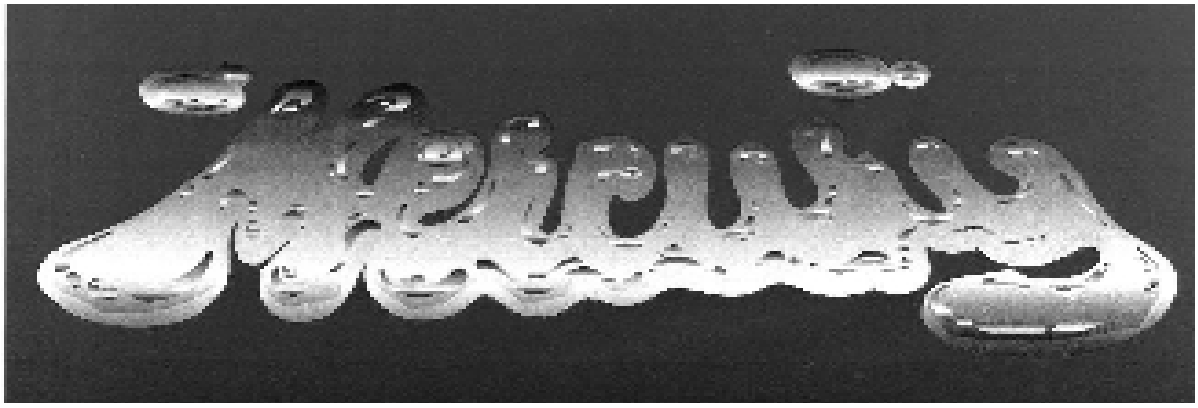

Mercury (the Element!) In Our Environment: Problems and Solutions

Curriculum and Teacher Resources

Grades: 4-8
Relevant Subject Areas:
Science, technology, social studies, math, health, current events

CET
Center for Ecological Technology

112 Elm Street, Pittsfield, MA 01201
Phone: 1-800-238-1221 Fax: (413) 443-8123
www.cetonline.org

Funding provided by the Massachusetts Department of Environmental Protection, Massachusetts Executive Office of Environmental Affairs, Housatonic River Restoration, and the Massachusetts Cultural Council, a state agency

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About this Curriculum

Mercury Awareness Education in the Classroom

When released into our environment, mercury can travel through the food chain - accumulating in wildlife, fish and humans. Mercury is extremely toxic in small quantities and can impair the human nervous system including mental function, vision and hearing. Most of the mercury in the environment is released through preventable human pollution. Offering education about mercury and related problems gives students the tools to apply solutions to their daily lives.

How to Use this Curriculum

This curriculum contains information, activities and resources that will help you teach your students about mercury in our environment. Begin by reading the fact sheet, "Mercury in our Environment" to understand why this has caught the attention of federal, state and local officials in addition to environmental and health activists. "A Guide to Eating Fish Safely in Massachusetts" answers many commonly asked questions about fish consumption. The overheads and accompanying script contain all of the details necessary to present this information. There are many activities included as part of the Extension. These hands-on lessons will help translate this information into concrete, relevant experiences. Choose the ones that work for you and the level of your students.

Massachusetts Department of Education Curriculum Frameworks: Related Learning Standards

Grade	Strand	Learning Standard
Grades 3-5	Earth and Space Science	The Water Cycle # 10: Describe how water on earth cycles in different forms and in different locations, including underground and in the atmosphere
Grades 5-6	Number Senses & Operations	6N16: Estimate results of computations with whole numbers, and with positive fractions, mixed numbers, decimals, and percents. Describe reasonableness of estimates
Grades 3-4	Data Analysis, Statistics & Probability	4D1: Collect and organize data using observations, measurements, surveys, or experiments, and identify appropriate ways to display the data.
Grades 7-8	Number Senses & Operations	8N1: Select and use appropriate operations—addition, subtraction, multiplication, division, and positive integer exponents—to solve problems with rational numbers
Grades 7-8	Patterns, Relations & Algebra	8P1: Extend, represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic expressions. Include arithmetic and geometric progressions, e.g., compounding.

Who is CET? Established in 1976, the Center for Ecological Technology, a non-profit organization is engaged in work that demonstrates and promotes practical, affordable solutions to the environmental challenges encountered in our daily activities. CET is active in the areas of waste reduction, recycling, composting, energy efficiency, renewable resources, water and indoor air quality and environmental education. CET provides education and technical assistance to schools, individuals, businesses and communities in western Massachusetts and other regions.

Mercury In Our Environment

Table of Contents

A Health & Environmental Hazard

Mercury in our Environment

CET
CENTER FOR ECOLOGICAL TECHNOLOGY

What is Mercury?

MERCURY IS A NATURALLY OCCURRING ELEMENT. Found in cinnabar, which is mined from the Earth's crust, mercury is refined and used in the manufacture of many products. In the home it may be found in thermometers, thermostats, fluorescent light bulbs, appliances, dental fillings and pharmaceuticals. It is also present in coal, oil and natural gas. Even though it has many useful qualities, ***mercury is extremely toxic to our health and environment.***

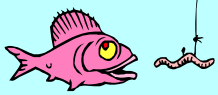
Health Hazards

MERCURY CAN CAUSE DAMAGE to the human brain, spinal cord, kidneys and liver. It affects the ability to learn, speak, feel, see, taste and move. Mercury in the diets of wildlife can cause early death and inability to reproduce.

When items that contain mercury break, breathing the toxic vapors or touching the mercury can cause serious health problems. The largest release of mercury into the environment occurs when fossil fuels (primarily coal) are burned for energy or when products containing mercury are incinerated or buried in landfills that may leak. Mercury becomes airborne, enters our waterways and is consumed by fish.

Most exposure to mercury is from eating fish. ***Pregnant women or women who may become pregnant, nursing mothers and young children should limit their intake of fish.*** The EPA recommends that these women and children limit their intake of freshwater fish to 1 meal per week. In addition, the MA Department of Public Health (MDPH) recommends avoiding larger fish (swordfish, shark, king mackerel, tilefish and tuna steak) because these fish generally accumulate higher levels of mercury. It also recommends eating no more than 2 meals a week of fish not covered by advisories.

Affected children show lowered intelligence, impaired hearing and poor coordination.

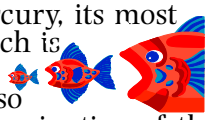


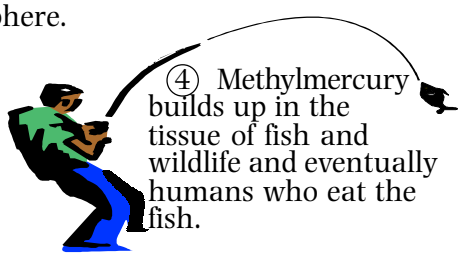
The Mercury Trail From Airborne....to Ailment

① When coal, oil, or natural gas are burned in power plants, or when products containing mercury are buried or burned, mercury becomes a gas that rises into the atmosphere.

② Mercury gas attaches to water droplets and returns to earth's waterways in rain and snow.

③ Bacteria in the water and other processes convert mercury into methylmercury, its most toxic form, which is absorbed by plankton. And so begins the contamination of the food chain.





④ Methylmercury builds up in the tissue of fish and wildlife and eventually humans who eat the fish.

⑤ Mercury in the body affects the brain, spinal cord, kidneys, liver and more. It is especially dangerous to fetal development and small children.

Reduce Your Use!

Household Products **That May Contain Mercury**		**Alternatives**
Thermometers	Fever; candy; deep fry; oven; temperature	Digital; Geratherm™
Thermostats	All non-digital	Electronic models
Flame Sensors	Gas fired appliances with pilot lights	Electronic ignition models
Batteries	Button batteries; most other types pre-1994 (except lithium and nickel cadmium rechargeables)	Rechargeables; new alkalines (after 1994); lithium
Switches & Relays	Car hoods; clothes irons; chest freezers; automotive lights	Ask if mercury-free models are available (mechanical or electronic switches)
Teeth Fillings	Dental amalgam	Ask your dentist about mercury-free alternatives
Fluorescent Lights	Standard fluorescents	Compact and low-mercury fluorescents*
Games; Jewelry	drawing screens, maze games	Mercury-free alternatives are available
Shoes; Greeting cards (mercury in button battery)	Products that light up or make noise;	
Pharmaceuticals	Certain brands of: topical disinfectants; nasal sprays, hemorrhoidal ointments; eye & contact lens products	Read labels, avoid products with Thimerosal™; phenylmercuric acetate; merbromim; phenylmercuric nitrate

Resources

- **Health Care Without Harm. PO Box 6806, Falls Church, VA 22040. noharm.org**
- **Mercury thermometer information: epa.gov/grtlakes/bnsdocs/hg/thermometers.html**
- **MA mercury strategy: state.ma.us/envir/mercury.htm**
- **state.ma.us/dph/beha/fishlist.htm (includes fish advisories)**

MA Toll-Free Mercury Hotline
1-866-9-MERCURY

Center for Ecological Technology (CET)
***1 (800) 238-1221* www.cetonline.org**
112 Elm St., Pittsfield, MA 01201 (413) 445-4556
26 Market St., Northampton, MA 01060 (413) 586-7350

Mercury Spill Clean-up

Immediately After a Spill keep all people and pets away! Minimize vaporizing of mercury; turn off heaters and turn up air conditioners. Open windows for at least two days if possible.

Never Use a Vacuum or Broom. The heat from a vacuum will evaporate the mercury. Using either will contaminate them and further distribute the mercury throughout the house.

Do Not Touch the Mercury! Remove jewelry/watches and put on gloves, preferably rubber. Use a flashlight to locate the mercury.

***To learn the correct method of cleaning a mercury spill, call the MA Toll-Free Mercury Hotline* 1-866-9-MERCURY**

Prevent Mercury Pollution

Reduce your use of electricity. Most mercury pollution comes from burning fossil fuels for energy. Buy products with the *Energy Star* ™ logo.

****Purchase fluorescent bulbs***. Although they contain mercury, they ultimately reduce mercury pollution as they can use up to 75% less energy.

Read labels! When possible, purchase products that do not contain mercury.

Tell your public officials that you support legislation that would require labeling of products that contain mercury.

Safe Disposal

Products containing mercury should be disposed of safely. Call your Town Hall, Department of Public Works or Board of Health to determine the correct way to discard these items.

Funding for this fact sheet was provided by the USDA Rural Development and the Berkshire Taconic Community Foundation. Information was adapted from materials produced by the Western Lake Superior Sanitary District (Minnesota) and Health Care Without Harm. CET is funded in part by the Massachusetts Cultural Council.

Sample Letter to Parents

March 24, 2002

Dear Parents/Guardians,

One topic being covered at school is mercury, the element that is found in household products such as thermometers, thermostats and fluorescent lamps/bulbs . Mercury presents a threat because it accumulates in animals and people and can produce adverse health effects. Mercury poisoning is possible just by breathing mercury vapors, which are invisible.

There are many efforts across the nation to educate people about mercury, risks from eating contaminated fish, and how to properly discard unwanted items. It is best to save them for your town's next household hazardous waste collection day for recycling or contact your town's Department of Public Works.

I encourage you to read the fact sheet, "Mercury in our Environment: A Health and Environmental Hazard" with your family. Your child will be asking to interview you or another adult and may also need some help completing the "Hunt for Mercury at Home". The more we know about how mercury poses a danger, how to handle products that contain mercury, and avoid purchasing them when possible, the safer we will all be.

Thank you.

This survey can be used as a pre and post "test" to gauge how much students have learned at the completion of this module.

Mercury Survey by _____ Date _____

We are going to study mercury pollution. Please answer questions about this topic. This is not a quiz! Do the best you can by circling the correct answer or writing an answer.

1. What is mercury?

   A) *compound* B) *metal* C) *plant*

2. Mercury can be dangerous to

   A) *People* B) *Animals* C) *People and animals*

3. Do you fish? *Yes* *No*

4. Do you think that mercury can get into the fish we might eat? *Yes* *No*

5. What items have mercury in them? Circle all correct answers.

   Thermometers *Some batteries* *Telephones* *Some light bulbs*

6. Name three of the five parts of the water cycle.

   _____ _____ _____

7. Becoming aware of the dangers of mercury and that there many products we can buy that don't have mercury are good ways to decrease mercury pollution. *Yes* *No*

8. Small animals get eaten by bigger ones. This is part of the _____ chain.

9. Which kind of light bulb uses less energy for the light it gives off?

   Fluorescent *Incandescent* *Halogen* *Neon*

10. What is the biggest source of mercury pollution in the U.S.?

    Power plants *Broken fluorescent bulbs* *Thermometers* *Dental fillings*

TOPIC: Mercury Awareness Education

TITLE: Mercury (the Element!) In Our Environment: Problems and Solutions

GRADE LEVEL: 4-8

TIME LENGTH: 45 minutes

GOALS: Students will become aware of the dangers of mercury and learn what they can do to decrease health and environmental risks

OBJECTIVES: Students will:
(1) learn characteristics of mercury
(2) name common products that may contain mercury
(3) realize potential health effects
(4) identify two sources of mercury pollution
(5) understand how pollutants can travel through air and water
(6) discover ways to decrease mercury pollution and associated health risks
(7) compare incandescent and fluorescent light bulbs and evaluate which one has economic and environmental benefits

MATERIALS:
- Transparencies
- Overhead projector
- Handouts and follow up materials

PROCEDURE: (See overheads and accompanying script)

ASSESSMENT: Provide students with a chance to verbalize what they have learned. Areas to evaluate include: was information learned or further developed; which experiences or parts of the lessons were new, interesting, and informative and which were not helpful and should be improved. Students can explain air patterns, the water cycle, food chain and calculate the savings using a fluorescent vs. incandescent bulb. Students can identify items that contain mercury.

EXTENSION: Many extensions are listed in the PROCEDURE. For further development, try the following:

- Hunt for Mercury at School (see Extensions J and K)
- Hunt for Mercury at Home (see Extension L)
- Ask students to make posters or write newspaper articles to teach others about the problems and solutions of mercury (see Extension M).

BIBLIOGRAPHY: *"Mercury: In Your Community and the Environment"*; Wisconsin Department of Natural Resources, Pollution Prevention Partnership
http://www.dnr.state.wi.us/org/caer/ce/eek/teacher/mercury2.htm

M.A.P., Mercury Awareness Program; Indiana Department of Environmental Management, Regional Household Hazardous Waste Task Force,
http://www.IN.gov/idem/ctap/mercury/map/index.html

Health Care Without Harm. PO Box 6806, Falls Church, VA 22040.
www.noharm.org

Mercury thermometer information:
www.epa.gov/grtlakes/bnsdocs/hg/thermometers.html

MA mercury strategy: www.state.ma.us/envir/mercury.htm

Fish advisories: www.state.ma.us/dph/beha/fishlist.htm

Mercury Awareness Education: Overheads Script

Overhead #1 **Outline**: What are some things that come to your mind when you hear the word mercury (no wrong answers, eg. planet, car). Mercury is also an element, something found naturally in the earth. Today we will talk about mercury because when it gets into the environment and our bodies, it can cause bad health effects. You will learn what mercury is, why it's dangerous, where you find it, how it gets into the environment and finally (and very importantly!) what we all can do to stay safe.

Overhead #2: **What is mercury?** We usually think of heavy metals as solids, and mercury is liquid.

Overheads #3&4: **Characteristics of Mercury**. It is the only heavy metal that is liquid at room temperature; it combines easily with other metals, such as silver, for dental fillings. Mercury has many unique qualities that make it useful in many different kinds of applications.

Overhead #5: **Harmful Impacts**. Although it is useful to us, mercury can also harm us. Later you will learn how it can get into our bodies. If this happens, it can affect our brain and organs, like the liver and kidneys. People who have mercury poisoning may have problems with vision, speech, hearing, breathing and learning.

Overhead #6: **Mercury at Home**. Many are familiar with mercury in fever thermometers. Does anyone have one at home? The mercury is contained in glass which can break easily if dropped. See if you have a circle dial down thermostat on a wall that regulates temperature. There may be one in the classroom. You can't see the mercury; it is contained in glass behind the case. For light switches at home, if there is no sound when turning a light switch on or off, it may contain mercury (this is called a silent switch; loud click sounds are made by mechanical switches). There may be mercury in appliances. How does the light for the refrigerator door go on when the door is opened? If you do not see a button/toggle switch, it may be operating with mercury. Same goes for a washing machine turning off when the door is opened. There is also mercury in some small round button batteries (found in watches, hearing aids, greeting cards and toys that make noise or light up). In cars it may be found under the hood for the light switch. Mercury is also used to make fluorescent light bulbs, and later we will learn why these are still better for the environment. Let's look for items with mercury that might be in this classroom (thermostat, fluorescent bulb, thermometers, some computers, anything with a button battery, teeth fillings. (For a more inclusive list, see handout in Getting Started, *Mercury in our Environment*).

Overhead #7: **How does mercury get into our air?** How is pollution transported? Do you remember if mercury occurs naturally in the earth, or does someone make it? It occurs naturally. Another place we find it is in fossil fuels, especially coal. What do we use fossil fuels for? Most of our electricity (54%) in the US comes from burning coal, and there is mercury naturally in coal. So when we burn it, what is being released into the air?

Overhead #8: **(Map of US)** A lot of coal is burned for electricity in the mid west, like Ohio, Indiana and Illinois, and also Pennsylvania. There are 600 coal plants in the U.S. How might this affect us? Later we will do an experiment to discover how air travels and what happens when there is pollution in the air. (See Extension A, page 27*, What Do You Smell?;* Extension B, page 28*, Stick 'em Up: Airborne Pollutants;* Extension C, page 30*, Pollution From Burning.*) We will see how pollution resulting from using electricity ends up coming back to us. In Massachusetts and New England, we don't burn as much coal for energy as they do in the mid-west, (six plants in MA) but we do burn a lot of trash (more than other states that rely on landfilling) as a way to get rid of it. This is also called combustion, or incineration. What happens when products that contain mercury are discarded in the trash?

Overheads #9&10: **Water Cycle**. (Either transparency with or without cycle parts filled in). If we know that the emissions from coal burning plants and waste incinerators are going into the air and traveling, does it stay in the air? What do pollution particles like mercury attach to? When they attach to clouds how do they come down? What are some examples of precipitation? What happens next? (See Extension D, page 31*, Water Cycle Model;* Extension E, page 32*, Nature's Water Wheel;* Extension F, page 34*, Water Cycle Game*.) When mercury gets into water bodies (lakes, rivers, oceans, etc.) some of it settles at the bottom. What is at the bottom of water bodies? (Soil.)

Overhead #11: **From Mercury to Methylmercury**. There is a chemical process that takes place when mercury mixes with the bacteria that are in soil. The chemical process turns the mercury into methylmercury. That's where the problem gets worse, because methylmercury is much more easily absorbed. What does that mean, to absorb? When you put lotion on your hands, where does the lotion go? What and who lives in water? The methylmercury is absorbed by the plants and also through skin/gills. The plants are eaten by fish and other aquatic life. When a little fish eats some algae, who eats the little fish?

Overhead #12: **Food Chain #1**. Who can explain the food chain in water bodies, or what's happening in this next picture....

Overhead #13: **Food Chain #2**. In water that has methylmercury in it, the bigger fish end up with larger amounts. Who is at the top of the food chain? If we eat large fish that have been contaminated with methylmercury, it will be absorbed by our bodies. (See Extension G, page 38*, Food Chain Game*.)

Overhead #14: **Fish Advisories**. Unfortunately, cooking or cleaning fish will not remove methylmercury. Some water bodies have fish advisories, or signs telling you that it is not safe to eat the fish because of mercury or other pollutants. Does this help the fish?

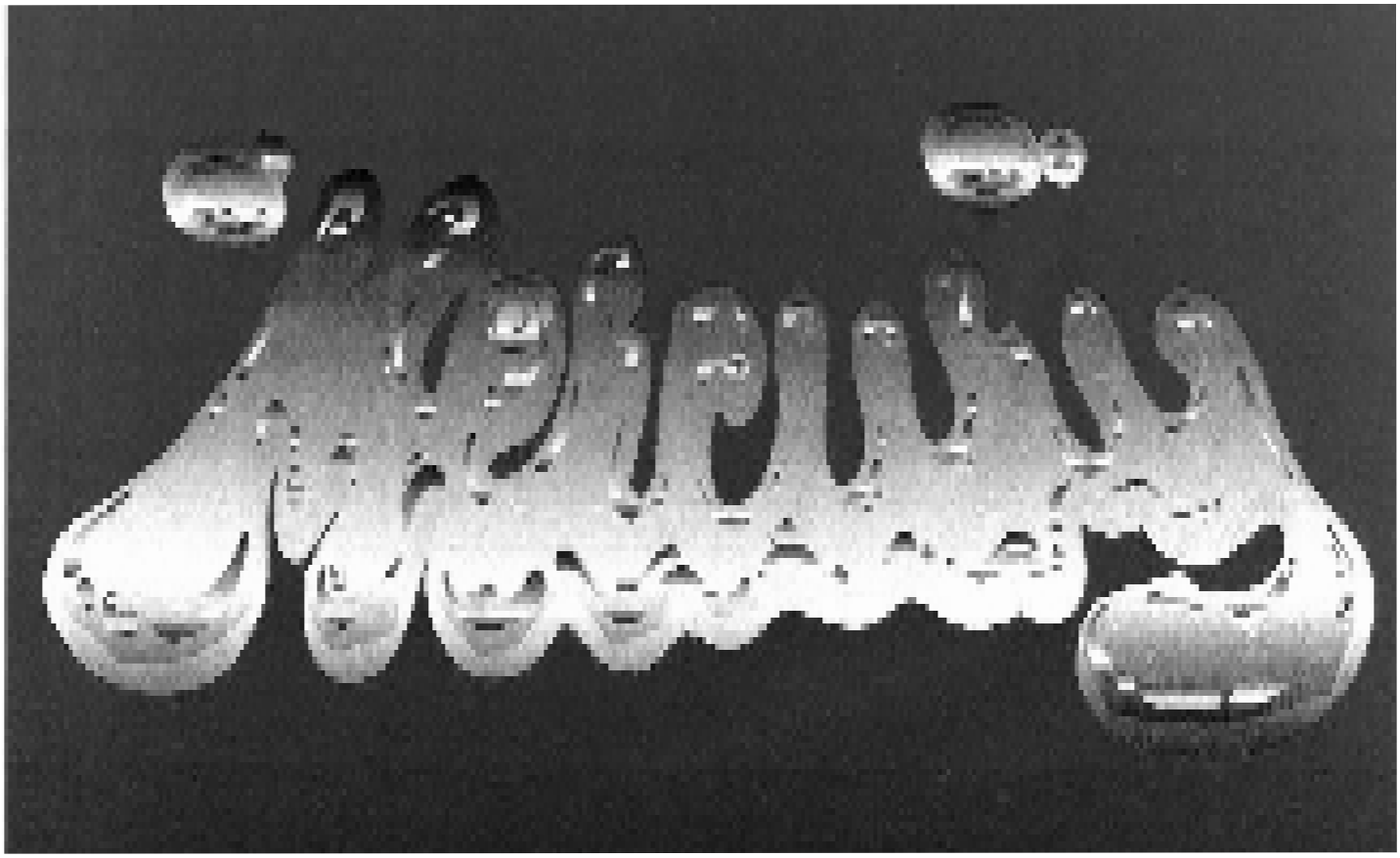
Overhead #15: **Solutions**. (Cover answers.) As is true with most environmental and health hazards, there are solutions. Can anyone think of ways to prevent mercury pollution? (Not eating mercury contaminated fish prevents negative health effects, not mercury pollution.) Who remembers the two ways that mercury gets into the air? Just like learning to play basketball, if you don't have information, you won't know how to play the game. Now that you know about mercury, you can talk to your families and others like I have helped you. The survey (see Extension H, page 42*, Adult Mercury Survey*) is a great way to find out how much someone knows, and then afterwards, educate them so they can make better choices. Like choosing to buy products without mercury, or making sure that products with mercury do not end up in the trash. How many of you use electricity (and how)? Remember earlier I said that even though these fluorescent light bulbs have mercury in them, they are still better for the environment? Any guesses why? That's because they are more energy efficient; they use up to 75% less energy than incandescent light bulbs. (See Extension I, page 43*, Calculate Your Savings: Energy Efficiency*.)

Remember, it is OK to eat some fish! Mercury is especially dangerous to growing babies still inside moms, and to all growing children (like you!). So it's important to not eat too much of the bigger types of fish, such as swordfish, shark, king mackerel, tilefish and tuna steak. For fish advisories, see www.state.ma.us/dph/beha/fishlist.htm.

Outline of Mercury Lesson

You will learn…

- What mercury is
- Why mercury is dangerous
- Where mercury is found
- How mercury gets into the environment
- What we all can do to stay safe

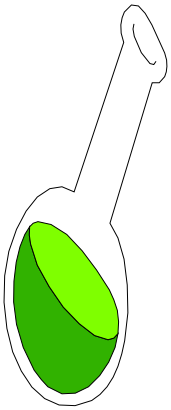


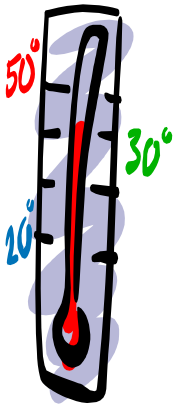
Mercury is:

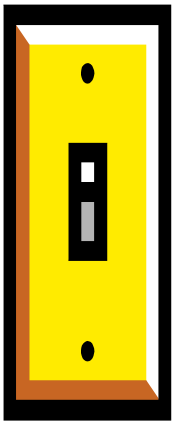
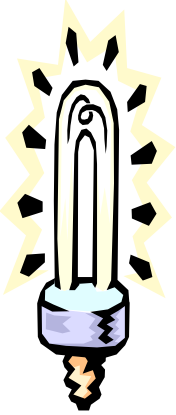
- a heavy metal;
- naturally occurring;
- highly toxic to humans, wildlife and the environment.

Characteristics of Mercury

- Liquid at room temperature
- Mixes easily with other metals
- Measures temperature
- Conducts electricity
- Element - never breaks down

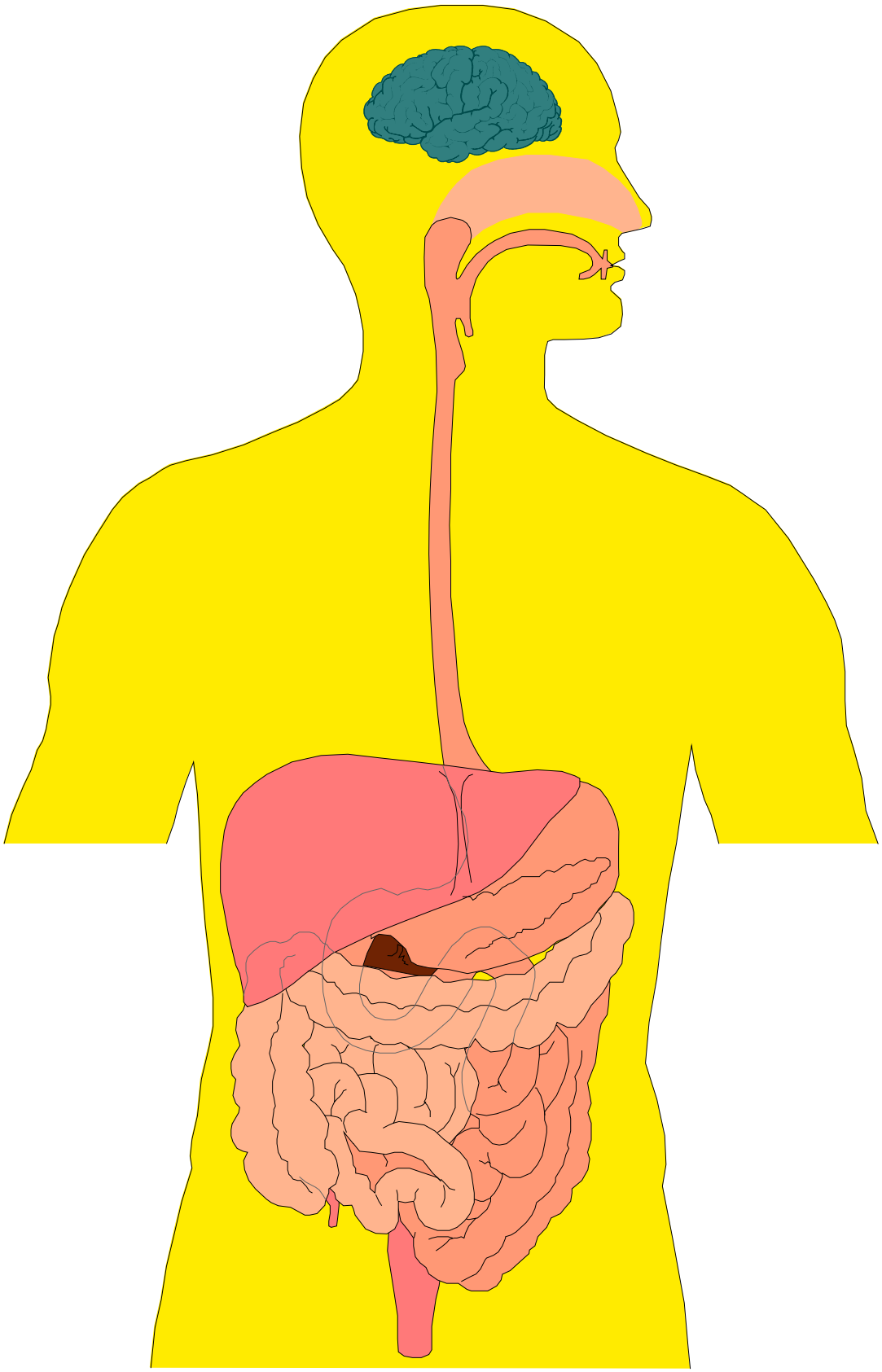




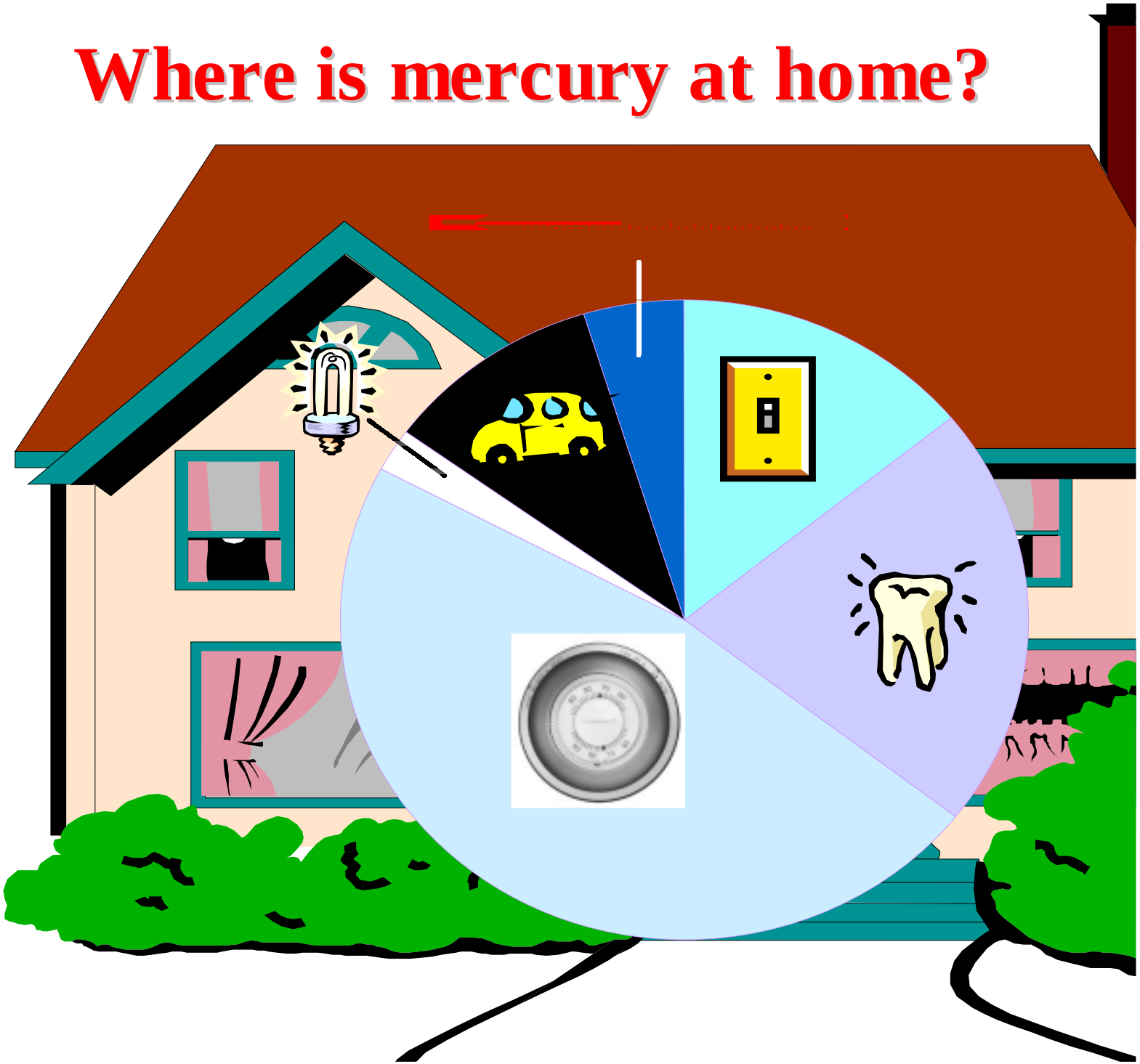



Unique Properties of Mercury

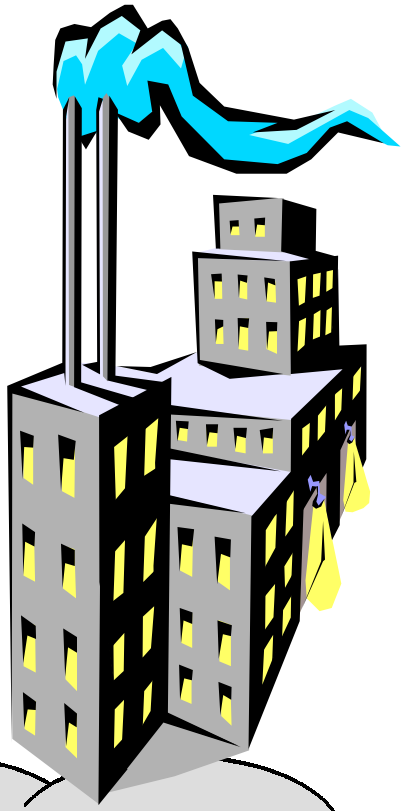
Property	Description or Usefulness
Property Mercury is the only metal that is liquid at room temperature.	**Description or Usefulness** This is one of the reasons mercury is so useful in switches.
Property Mercury evaporates at room temperature.	**Description or Usefulness** This is not a unique property for a liquid but a very unique property for a metal. It is one of the ways that people can be exposed to mercury.
Property Mercury is extremely dense.	**Description or Usefulness** Two tablespoons of this liquid weigh about 1 pound.
Property Mercury conducts electricity.	**Description or Usefulness** It is used in electrical “tilt” switches and other electrical devices.
Property Mercury expands and contracts uniformly with changes in temperature.	**Description or Usefulness** It is used in thermometers and thermostats.
Property Mercury readily combines with other metals.	**Description or Usefulness** It is used in “amalgams” where it is combined with silver to fill cavities in people’s teeth.
Property Mercury kills bacteria and fungi.	**Description or Usefulness** It was previously used in pesticides and paints to kill germs. It is still used in some health products.



Where is mercury at home?



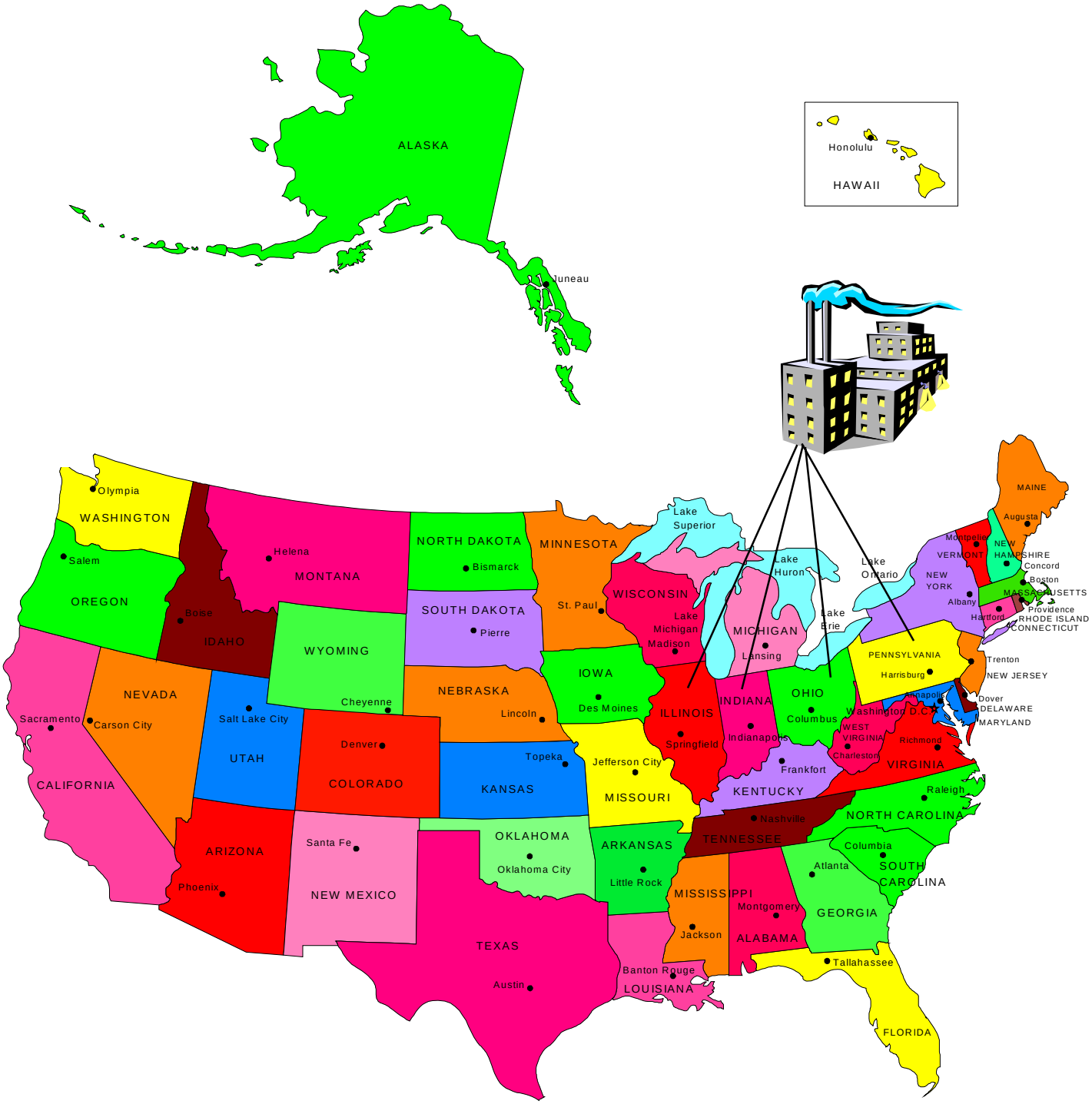
How does mercury get into our air?



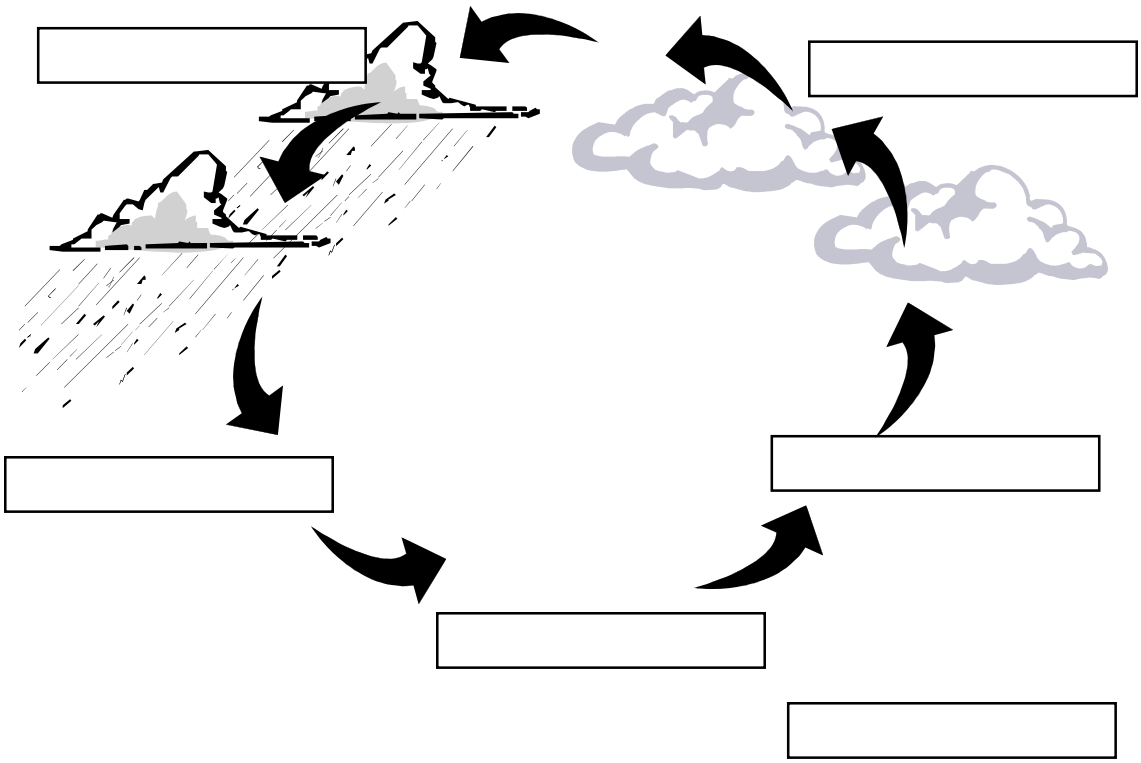
Burning Coal to Create Electricity

Burning Trash to Get Rid of It

United States of America



Nature’s Waterwheel

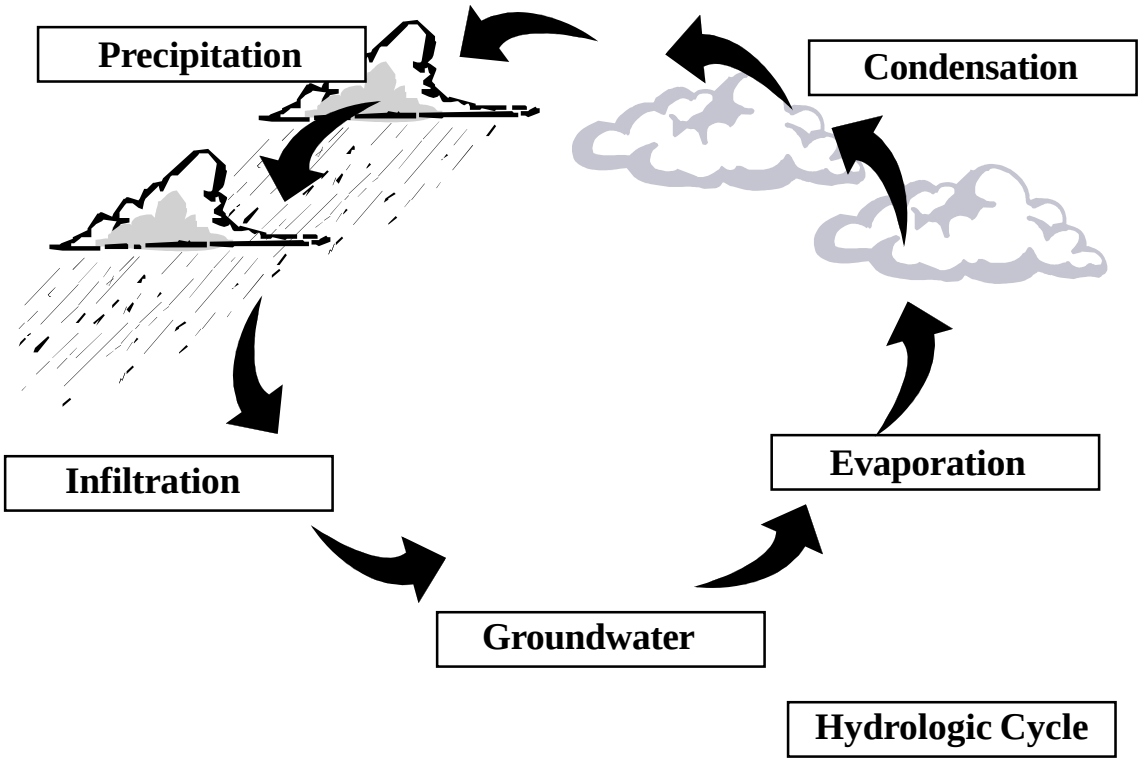


Water Cycle

- **Condensation** - The changing of water vapor to liquid
- **Evaporation** - The changing of water into water vapor
- **Groundwater** - Water found below the surface of the earth
- **Hydrologic Cycle** - Process involving the circulation and distribution of water on earth
- **Infiltration** - The process by which water seeps into the soil
- **Precipitation** - Forms of condensed water vapor that are heavy enough to fall to the earth’s surface, such as rain, snow, sleet, hail and fog.

Reprinted from “Action for a cleaner tomorrow”

Nature's Waterwheel



Water Cycle

Think about the water on the ground. The water on the ground evaporates when the ground gets warm. Think about the warm air rising. The air and water vapor expand and rise high. The air is cooled when it rises. When air is cooled, the water vapor condenses. The water vapor condenses to make clouds. Cloud drops come together to make bigger water drops. The bigger drops are rain. Rain falls on the ground. Some of the water seeps into the soil and moves underground as groundwater. It may feed into streams and lakes. The water evaporates again. The whole cycle starts again.

Reprinted from "Action for a cleaner tomorrow"

In Water, (streams, lakes, rivers, oceans) Mercury is Transformed to a Very **TOXIC FORM**

Mercury

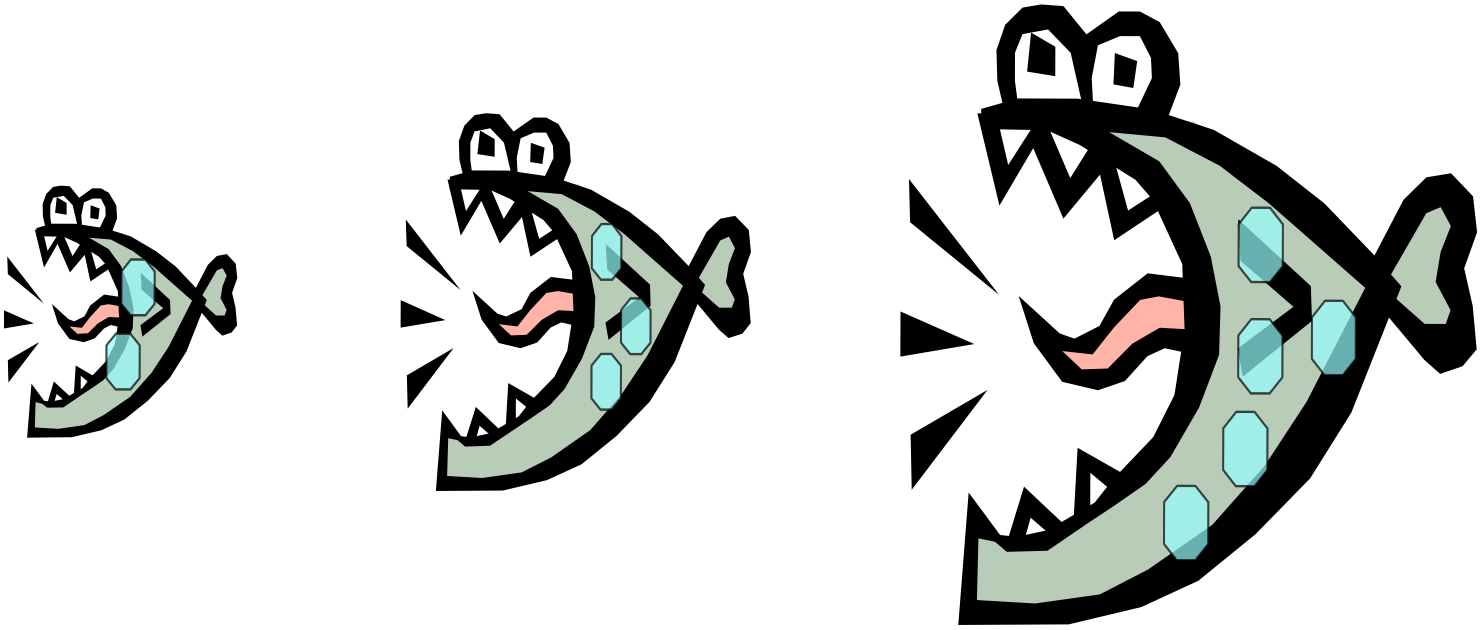
↓

Bacteria and Chemical Processes

↓

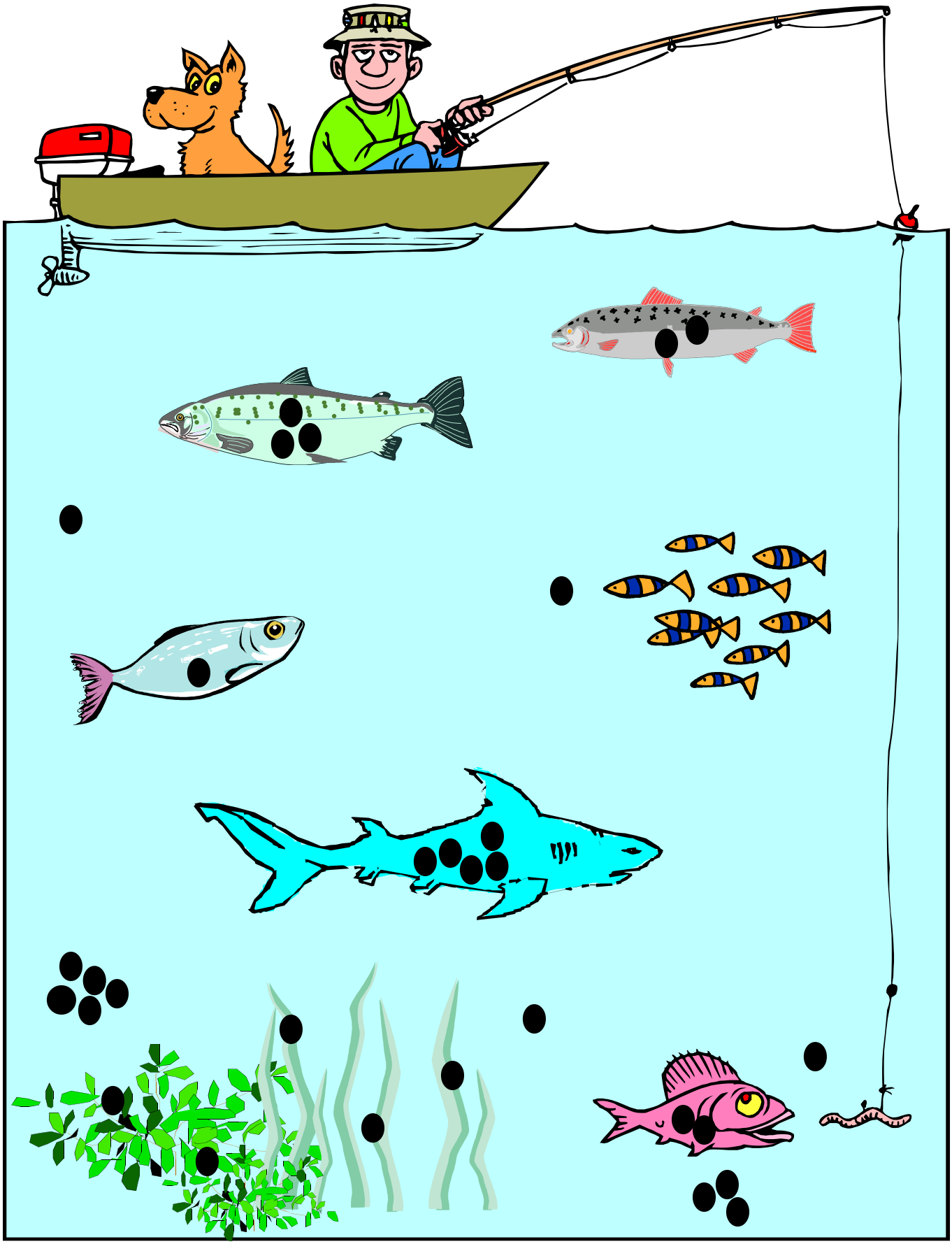
Methylmercury

Methylmercury Increases up the Food Chain



2 + 3 = 5

- Methylmercury

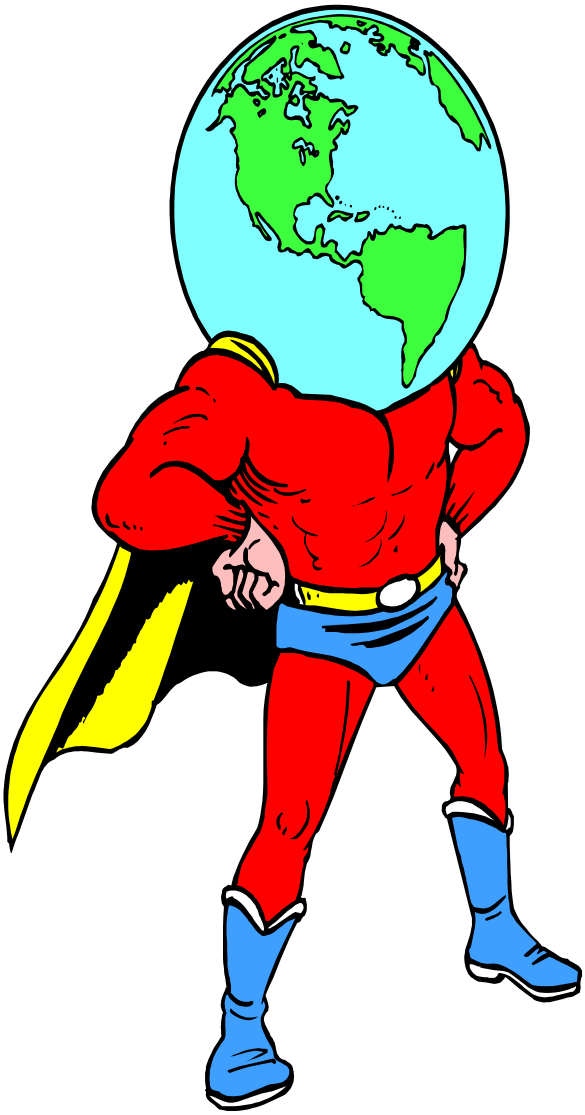


● represents methylmercury

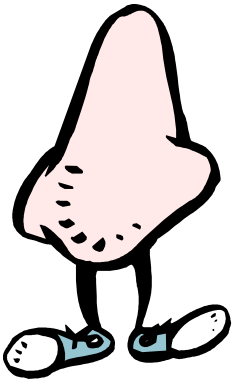
Mercury in Fish can Harm Humans and Animals

- Fish advisories tell people how much fish is safe to eat.
- Animals and fish that eat other fish cannot read the signs or change their eating habits.

You Can Prevent Mercury Pollution



- Educate yourself and others
- Buy mercury-free alternatives
- Keep mercury OUT of the garbage
- Conserve electricity



TITLE: What Do You Smell?

TIME LENGTH: 30 minutes

OBJECTIVES: Students will:
(1) Use creative imagery to think about the effects of air pollution
(2) Demonstrate the concept of air pollution travelling from one region to another
(3) Understand how mercury can be a "silent" polluter

MATERIALS: Cut up onions
Fan
Map of the United States

PROCEDURE

A. Have students close their eyes and think of a place or a thing that has a strong smell. Maybe they have smelled a skunk road-kill. Sometimes when in a car you can smell the skunk, and not see it for several minutes.

B. Ask for a volunteer reporter. Use a fan to blow over a freshly sliced onion in the front of the class. Have students raise their hand when they can smell the onion. The reporter should record who smells it first, second, etc.

QUESTIONS:

1. Why did the people in front smell the onion first? Why did it take a while before the people in the back smelled it? What conclustion can you make about the effect of wind on air pollution?

2. Can you always smell pollution? No, mercury pollution is an example of pollution that you cannot smell.

3. If you have a cold or stuffed up nose, would that prevent you from smelling the onion? Does that mean that if the onion was really pollution, it wouldn't effect you?

4. What if someone has asthma, emphysema or other respiratory ailment? Would that person be more at risk from air pollution?

5. Most of the coal burning power plants are located in states such as Pennsylvania, Ohio,Indiana and Illinois. How does the pollution from those smoke stacks effect people in Massachusetts?

Stick ‘em Up

Preparation Time:	Easy-to-do	**Moderate**	Extensive

Grade:	4 - 5
Focus:	Airborne pollutants
Subject:	Social Studies, Science
Materials:	See list below
Teaching Time:	Two class periods (about a week apart)
Vocabulary:	Smog, airborne, particulate matter

Learning Objective

Students will:

- learn that tiny particles are forever floating around in the air we breath;
- collect, observe, and analyze these particles from various locations around their school or community.

Background

The air around us is invisible. It is made up of gases that cannot be seen. Many major air pollutants are also invisible gases. In some areas of the country, these air pollutants can build to levels where they can be seen. For example, in some California cities, smoky, yellowish clouds of primary car exhaust build up to create **smog**.

Other easily visible air pollutants, called **particulate matter**, are made up of tiny particles of solids or droplets of liquids. Some of these particulates are naturally occurring and may pose less of a problem to human health than do man-made particulates. Some of the natural particulates include pollen, windblown dust or volcanic ash.

Man-made particulates are generated by coal and oil-fired power plants and manufacturing plants, automobile and diesel fuels, and fireplaces and wood-burning stoves among others. These **airborne** particulates, or particles, carried through the air, can be harmful to plants, animals, and humans. Buildings and statues can be discolored.

Questions for the Class

1. Can we see air pollution? How do we know that air pollution exists?
2. Give examples of visible air pollution.
3. Discuss the concept of particulate matter.
4. List some sources of air pollution, both visible and invisible. Can a single source provide both visible and invisible air pollution?

Materials

- *Stick ‘em up* sheet (included) of particulate collectors
- scissors
- clear tape
- string
- hole punch
- magnifying glass (microscopes optional)
- marker

Learning Procedure

1. Copy the Stick ‘em Up sheet (included) so that each student has a particulate collector.

This lesson is reprinted from “**Action for a cleaner tomorrow: A South Carolina Environmental Curriculum Supplement**” and is provided by the **S.C. Department of Health and Environmental Control’s Office of Solid Waste Reduction and Recycling.**

2. Cut four holes ~1.25” in diameter in the strip as marked. Using the hole punch, make a hole in the top and tie the string into a loop.

3. Cover one side of the strip with clear tape so that the holes are covered on one side. **Do not touch the sticky side of the tape that is showing through the holes.**

4. Select different sites around the school to hang the Stick ‘em Up collectors. On each strip, record the student’s name, location, date, and time it is hung. Site selections may include inside your classroom, in the hall outside your classroom, in the gym, bathrooms, cafeteria, office, teacher’s lounge, outside near a tree, near the parking lot, etc. These should be placed where they can hang freely, not touching other surfaces and where they will not be touched by other students. Be sure to let the custodial staff know about this, too.

5. After a week, retrieve the Stick ‘em Up collectors and analyze. First have the students do a cursory inspection, reviewing the strips with the naked eye. What did they find? Next, have them inspect the strips with the magnifying glass or, if you have microscopes, use them instead. What did they find?

Extension Activity

Make a traffic survey. Pick a location where students can observe a busy intersection from a safe distance. Separately record the number of trucks, cars, buses, vans, and taxis that pass through that intersection in a given hour. Try this over several days at different times of days.

- **Ask:** What factors influence volume of traffic? (*locations of highways, number of people in the community, shopping centers, businesses, special events, etc.)*

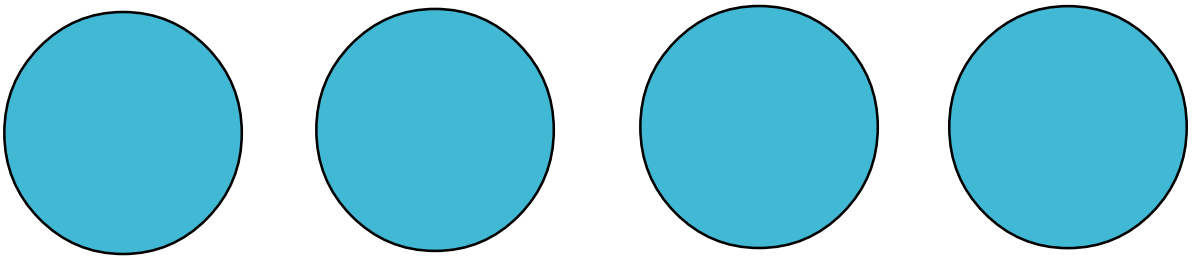
- **Ask:** Did you see any evidence of air pollution? *(smells, smoke, wilted plants struggling to survive, etc.)*

- **Ask:** Do you think this is a problem? Why or why not. If so, what do you think should be done to correct it?

Name: _____

Location: _____

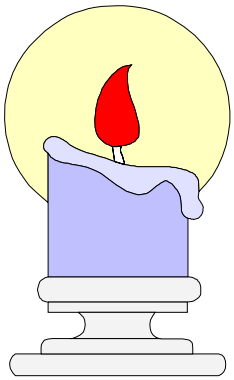
Date: _____ Time: _____



TITLE: Visible Pollution

PURPOSE: To show how burning can release invisible and visible pollution

MATERIALS: Birthday candle
Lump of clay (tea light candles which have a broad, flat base may be used as a substitute for birthday candles and clay)
Heat-resistant glass cover, such as petri dish or heat resistant microscope slide
Matches



TIME: 20 - 30 minutes

PROCEDURE Light the candle and ask students what is burning and why. Discuss why the candle does not show any smoke. Pass the glass cover over the candle to cool the flame. The glass will turn black. Ask the students what happened. Blow out the candle and observe the smoke. You can also try re-lighting the candle through its smoke trail by placing a lighted match within the trail.

CAUTION An adult should demonstrate this activity to students. Students should be reminded to stay a safe distance away from the candle to prevent burns.

Expected results and reasons they occur: *Mostly candle wax is burning, but a bit of the wick is burning also. The candle does not show any smoke because it burns efficiently with lots of heat/ light and little waste (i.e. soot, which is unburned fuel). Cooling the flame by passing a cool glass over it reduces efficiency, and the glass collects unburned fuel. Blowing out the candle reduces the temperature of the tiny burning ember on the candle wick, producing smoke (i.e. unburned fuel). If the candle re-lights though the smoke, it is showing that smoke and soot are unbuned fuel -- the result of incomplete combustion -- and can be burned when re-ignited.*

Adapted from Indiana Department of Environmental Management's Project LEAP

(From: PITSCO Product Catalogue)

Water Cycle Model Activity Set

Make it rain in your classroom! Students can duplicate the individual processes of the water cycle (evaporation, condensation, and precipitation) with this ingenious model. Accompanying set of ten 8-1/2″ x 11″ full-color study prints will broaden students' understanding of the water cycle and enhance awareness of the various states of water.

Level: Intermediate - High School
#AA55553 - $79.95

http://www.shop-pitsco.com/pitsco3/finditem.cfm?itemid=3171

Nature's Water Wheel

Preparation Time:	Easy-to-do	**Moderate**	Extensive

Grade:	4 - 5
Focus:	How the water cycle works
Subject:	Social Studies, Science
Materials:	Tea kettle of water, hot plate, pan of water, pan of ice cubes, pot holders, "Nature's Waterwheel" transparencies and/or handouts
Teaching Time:	One class period
Vocabulary:	Hydrology, condensation, evaporation, groundwater, water cycle, infiltration, precipitation, water vapor, surface water, water table, pollution

Learning Objective
In this activity, students will help create a model and demonstration of the water cycle. Students will see how nature's water cycle works.

Background
Hydrology is the study of the movement and distribution of water on the earth. In nature, water circulates through a system called the **water cycle** or **hydrologic cycle.** This cycle begins when heat from the sun causes ocean water to **evaporate** and become **water vapor**. The atmosphere holds the water vapor while the vapor gradually cools and forms clouds. The water eventually falls as rain or snow. Most rain and snow fall back into the oceans. But some falls on the land and flows back to the seas, completing the cycle.

There are two main sources of fresh water: **surface water** and **groundwater**. Surface water flows over the land in lakes, rivers, and streams. Groundwater seeps through the soil or through cracks and cavities in rock.

Groundwater is water beneath the surface of the earth. It is the source of water for wells and springs. Groundwater provides much of the fresh water in the United States.

Groundwater accumulates chiefly from rain that filters through the soil. It also forms from water that seeps into the ground from lakes and ponds.

The surface of groundwater, called the **water table**, drops when more water is withdrawn than can be replaced naturally. **Pollution** of the groundwater is a serious problem. Pollutants that seep into the ground can come from a wide variety of **point sources** such as specific chemical spills and **nonpoint sources** such as agricultural runoff and other sources that cannot be directly pinpointed.

This lesson is reprinted from "**Action for a cleaner tomorrow: A South Carolina Environmental Curriculum Supplement"** and is provided by the **S.C. Department of Health and Environmental Control's Office of Solid Waste Reduction and Recycling.**

Learning Procedure

1. Provide each student with a copy of the first page of "Nature's Waterwheel" handout or use a transparency to discuss the water cycle.

2. Explain to students that you can demonstrate the basic elements of the water cycle in class.

NOTE TO TEACHERS: Please supervise students carefully during this demonstration. Remind students that the steam is actually hotter than the boiling water.

3. On a table where students can observe, place the hot plate and the tea kettle filled with water. Heat water until it boils. This heat represents the heat of the sun on the ocean.

4. Using the pot holders, hold the pan of ice cubes over the steam from the boiling water. Steam from the boiling water condenses when it hits the cold ice cube pan. The condensed water then falls back into your water pan that can be poured into the tea kettle to be changed to steam again, completing the cycle.

5. Explain to students that there is more to the water cycle. Part of the cycle actually takes place under the earth, in the ground. Discuss how water eventually seeps into the soil (infiltration) and forms groundwater.

6. Have students refer to the second page of their handout, "Nature's Waterwheel" and complete their diagrams as you discuss the elements of the water cycle.

Questions for the Class

1. In the demonstration, what represents the sun? *(The kettle of boiling water. It is the heat source.)*

2. What represents the clouds? *(The outside surface of the pan of ice cubes. It is where the water vapor condenses.)*

3. What represents the rain? *(The water droplets falling from the pan of ice cubes.)*

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TOPIC: Mercury Awareness Education: Water Cycle Review

TITLE: Water Cycle Game

GRADE LEVEL: 4-6

TIME LENGTH: One 20 minute lesson

OBJECTIVES: Students will:
(1) review the steps of the water cycle
(2) demonstrate how the order of each step relates to the next step

MATERIALS: Water cycle parts, enough for each student to have one (see attached). Cut and paste each one onto paperboard/cardboard

PROCEDURE:
1. Review the steps of the water cycle.
2. Give each student one part of the water cycle.
3. Ask the students to walk around and locate the other 4 parts of the water cycle, so they end up in a complete set, in the correct sequence.
4. Have each circle of students walk in a circle to represent how the cycle moves.
5. Add to this game by shouting out one step of the water cycle. Those students that are holding that card should switch to another group water cycle circle. (Repeat.)

Condensation

Evaporation

Groundwater

Infiltration

Precipitation

TOPIC: Mercury Awareness Education: Mercury Travels Through the Environment

TITLE: Food Chain Game

GRADE LEVEL: 4-6

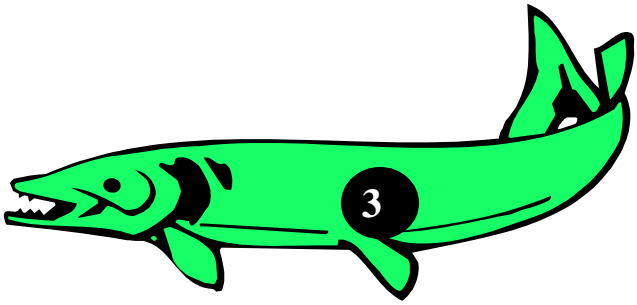
TIME LENGTH: 30 minutes

OBJECTIVES: Students will:
(1) understand the food chain
(2) demonstrate how mercury travels up the food chain

MATERIALS: - aquatic life pictures (see next two pages). Preferably colored and laminated.
- string/rope, large enough so all of the students can walk around in a circle created by the string or rope

PROCEDURE: 1. Place string or rope in a circle on the floor to represent a body of water.
3. Place all the aquatic life in a bucket.
4. Students go "fishing" by reaching into the bucket and pulling out an aquatic life piece and stepping into the water.
5. Students should notice what number they have. Numbers indicate how high up they are on the food chain and also number of mercury "units".
6. Students walk around and try to find a lower number. Once s/he has found a lower number, s/he is able to "eat" it, and asks the lower one to hand his/her aquatic life over.
7. Only number fives should be left. These people should add up the number of mercury units they have consumed including the number he/she started out with.

DISCUSSION QUESTIONS 1. Although the ones with low numbers have been eaten, what is the larger animal left with?
2. Once the largest fish have eaten all of the smaller ones, can they get rid of the mercury that is now stored in their fatty tissues? (No!)
3. Who is at the top of the food chain? (Us!)
4. Can you tell if a fish has been contaminated by mercury by looking at it? (No.)
5. Can you cook or clean fish in such a way as to get rid of the mercury? (No.)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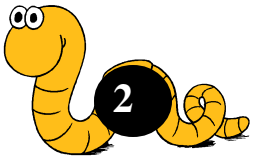
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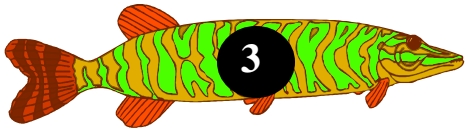
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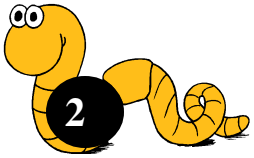
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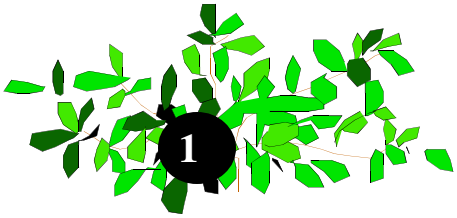
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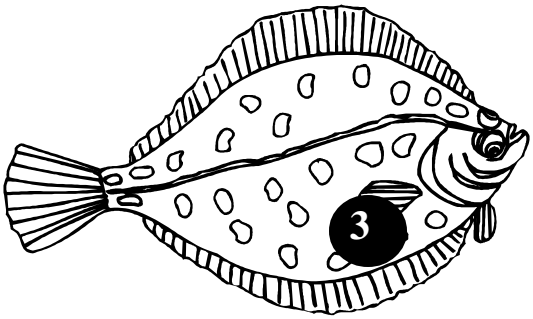
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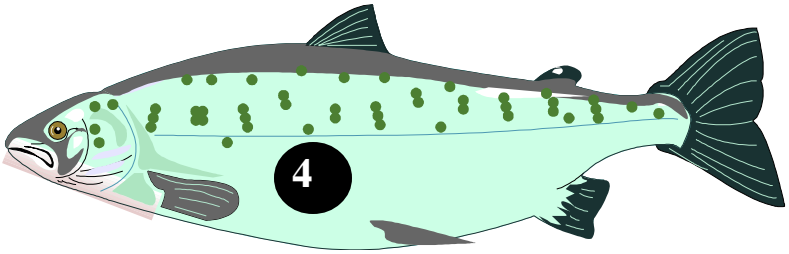
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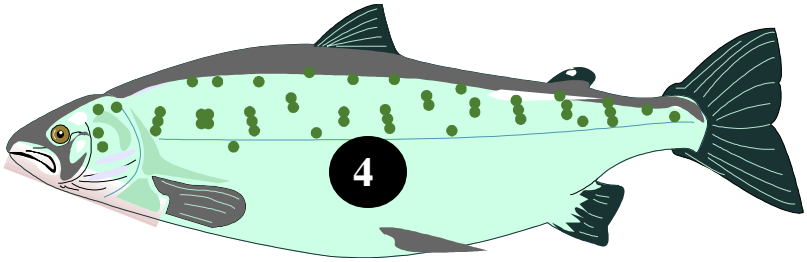
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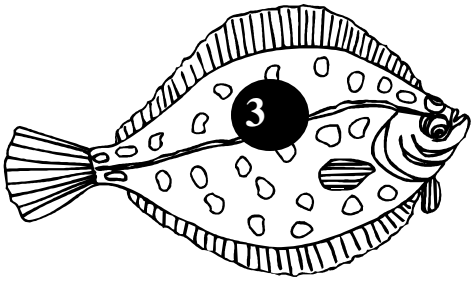
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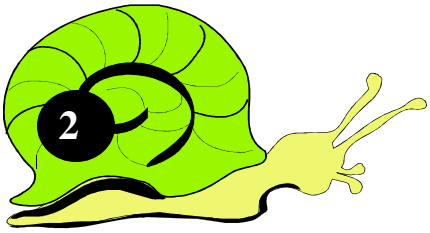
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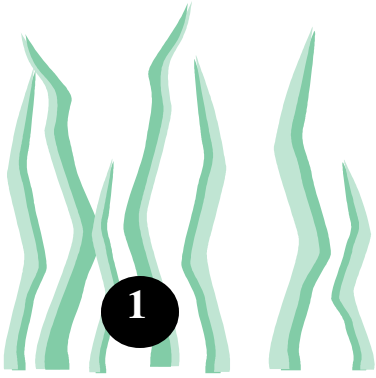
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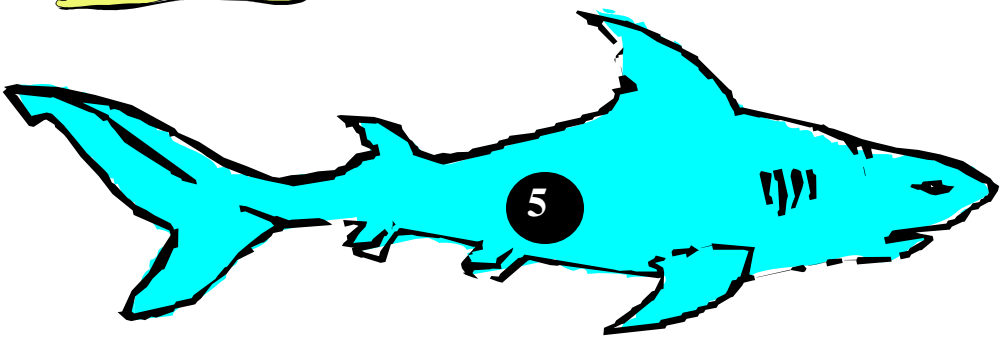
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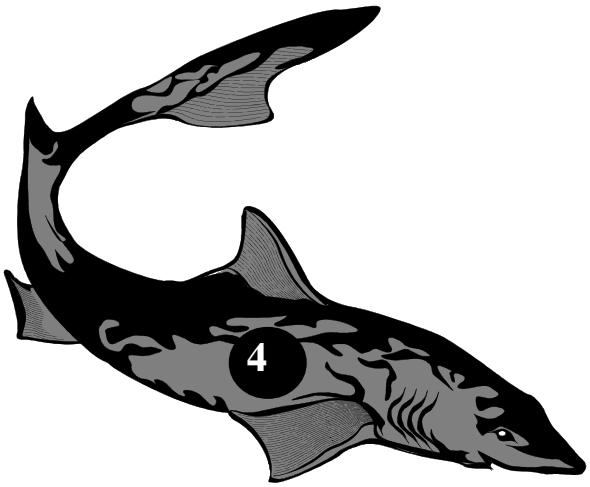
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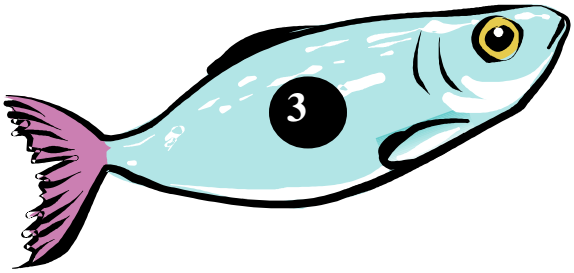
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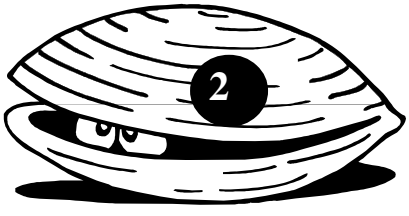
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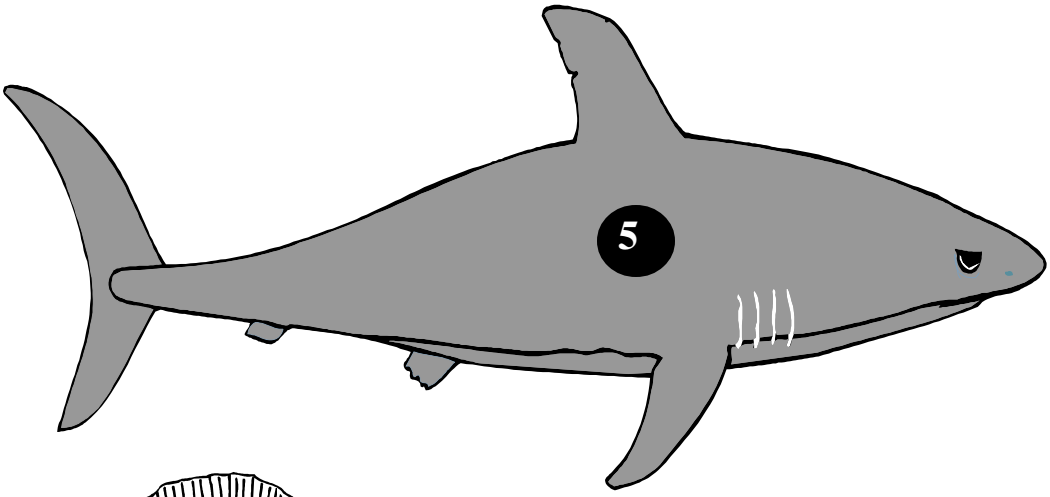
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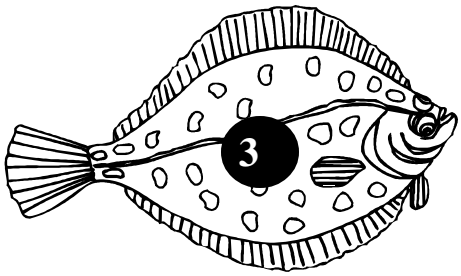
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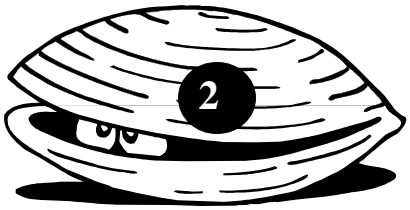
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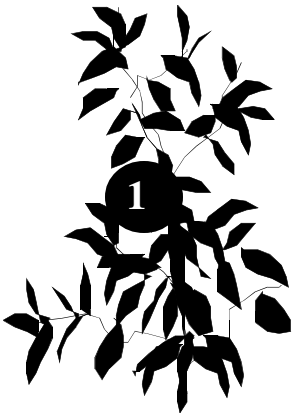
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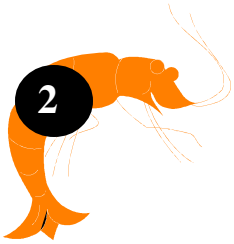
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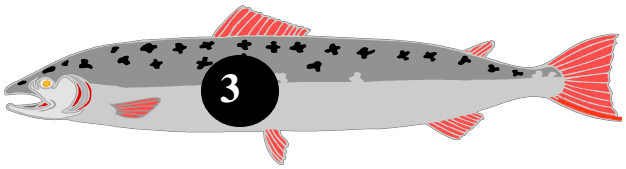
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Mercury Survey by _____ **Date** _____

We are studying mercury (the element!) in class. I am doing research on mercury in our community and would like to ask you several questions about this topic.

1. Do you consider mercury dangerous to human health? *Yes* *No*

2. In the last year, have you heard or read of any local or national news story that involved mercury? *Yes* *No*

3. Do you fish? *Yes* *No*
   If yes, have you seen any fish advisory that describes the warnings for eating fish from certain bodies of water in Massachusetts? *Yes* *No*
   (Check out the website www.state.ma.us/dph/beha/fishlist.htm)

4. Do you know that mercury fever thermometers are no longer sold in stores like Wal-Mart and Brooks, and are also banned from being sold in the city of Boston? *Yes* *No*

5. Items that contain mercury (such as toys, thermostats and thermometers) should be clearly labeled.

   Strongly Agree *Agree* *Disagree* *Strongly Disagree*

6. Mercury can cause damage to the brain, kidneys and liver. *True* *False*

7. The burning of fossil fuels like coal releases mercury into the air. *True* *False*

8. All thermometers contain mercury. *True* *False*

9. Over forty percent of lakes and ponds tested in Massachusetts have one or more types of fish with unsafe levels of mercury. *True* *False*

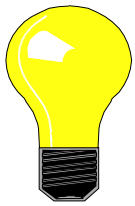
Thank you.

Name_____ **Date**_____

Calculate Your Savings

Comparing Bulbs Producing the Same Amount of Light

The largest source of mercury to the environment nation-wide is from coal burning electric power plants. The coal that is burned to produce electricity contains a small amount of mercury. However, because so much coal is burned, the amount of mercury released into the air is very significant. We use a lot of electricity in our homes. Let's figure out if the choice of light bulbs can make a difference in the amount of energy used and cost.

	1 Incandescent Light Bulb		**1 Fluorescent Light Bulb**
Energy:	**60 watts**		**15 watts**
Life:	**1,000 hours**		**10,000 hours**
Cost of bulb:	**$ 1.00**		**$10.00**
Cost of electricity (at 10 cents per kilowatt hour)	**$6.00**		**$15.00**

1. An incandescent bulb uses _____ times as much energy as a fluorescent bulb.

2. A fluorescent bulb lasts _____ times longer than an incandescent bulb.

3. How much do you need to spend on light bulbs to last 10,000 hours? (Hint: How many bulbs are needed to last 10,000 hours? Multiply that number by the cost per bulb.)

Incandescent $ _____ **Fluorescent** $ _____

4. How much do you spend on electricity for 10,000 hours of light? (Hint: Multiply the number of bulbs needed to last 10,000 hours times the cost of electricity per bulb)

Incandescent $ _____ **Fluorescent** $ _____

5. What is the total cost for bulbs plus electricity?

Incandescent = $ _____ **Fluorescent** = $ _____

6. Which costs less overall, the incandescent bulb or the fluorescent bulb? **Incandescent** **Fluorescent**

7. How much do you save over the lifetime of the bulb? **$_____ per bulb.**
(Hint: Check answers from #5. Subtract the total cost for the fluorescent bulb from the total cost of the incandescent bulb.)

Hunt for Mercury at School

Name _____ Date _____

Item	Contains Mercury (Yes/Maybe)	Location	Alternative?

School Staff Walk-Through Mercury Checklist

_____
Name of School

This checklist is designed to assist in identifying and locating products and equipment that contain mercury in schools.

Contact Information: Name _____ Title: _____ Phone: _____

Fax: _____ E-mail: _____ School Address: _____

	Item	Have? No	Have? Yes	Quantity	Location	Needed Replacement?
Science, Chemistry, Physics	Elemental mercury					
	Lab thermometers					
	Barometers					
	Vacum gauges					
	Hg Spectral Tubes					
	Mercury compounds					
	Mercury hygrometer					
	Mercury hydrometer					
	Mercury vacuum gauge					
	Hg spectral tube					
	Mercury sling psychrometer					
	Mercury gas law apparatus					
	Other					
Facilities	Thermostats					
	Fluorescent lamps/bulbs					
	Gauges with liquid mercury					
	"Silent" switches (light, other)					
	Float control switches (on sump pumps)					
	Flow meters (with mercury switches)					
	Displacement/Plunger relay					
	Flame Sensor/Safety valve					
	Old fungicides/Pesticides (prior to 1991)					
	Mercury lamps (vapor, metal halide, neon)					

	Item	Have? No	Have? Yes	Quantity	Location	Need Replacement?
Medical	Mercury fever thermometers					
	Mercury sphygmomanometers					
	Pharmaceuticals Certain brands of: topical disinfectants; nasal sprays, hemorrhoidal ointments; eye & contact lens products. Avoid products with Thimerosal[tm]; phenylmercuric acetate; merbromim; phenylmercuric nitrate					
Home Ec & Art						
	Mercury cooking thermometer					
	True vermillion paint (mercuric paint)					
	Cadmium vermillion red					
Batteries	Button batteries					
	Old alkaline type, pre-1996					
	mercury oxide					
	mercury zinc					
	Other					
Lamps	Fluorescent bulbs/lamps					
	Mercury vapor lamps					
	High pressure sodium lamps					
	Neon lamps					

Hunt for Mercury at Home

See fact sheet, "Mercury in our Environment" to help you locate items that may contain mercury

Name _____ Date _____

Item	Contains Mercury (Yes/Maybe)	Location	Alternative?

Questions for Discussion Following Home Inventory

Which items did students find that contained mercury? Thermometers, pharmaceutical products, thermostats, fluorescent lights, button batteries.

What are some non-mercury alternatives to these products?

How might a thermostat used in your home contribute to mercury pollution in the environment once the thermostat becomes waste?

All of these mercury items must be handled as hazardous waste once someone wants to dispose of them. How does your community handle hazardous waste?

Mercury Awareness Assignment

There are many ways to educate the public about the health and environmental concerns associated with mercury and possible solutions. Now that you have learned about mercury, you can help make the public more aware of the mercury issue by choosing one of the following projects:

1. Write a newspaper article about mercury. Writing should be clear, well organized, accurate and informative. Remember the steps in the writing process: draft, revise, edit and produce a neat, final project.

OR

2. Create a poster about mercury. Be creative, eye-catching, accurate and informative. You can use a variety of materials or pictures. Be sure all spelling is correct and lettering is neat.

Either project should include as many of the following points as possible:

What is mercury?
Where do we find it in our homes and community?
What are some of the different ways we can be exposed to mercury?
What are the problems associated with mercury? Why is it dangerous?
What are some actions we can take to reduce risk to our health and the environment? (Such as purchasing products that do not contain mercury, using less electricity and disposing of mercury containing products properly.)

Projects are due: _____

School Mercury Reduction and Recycling Pledge

We pledge to continue to keep mercury out of our schools and the environment in order to protect our children's health and air and water quality. We understand that mercury performs a useful function in thermometers and other instruments; however, it can also pose significant health and environmental dangers.

Our school is committed to protecting our students and the environment. Therefore, we, the undersigned Massachusetts school, have established these goals to minimize the impact of mercury on the environment and encourage school staff, students and parents to conduct sound environmental practices as well.

To achieve these goals, we pledge to:

- **Inventory our buildings for items that contain mercury**
- **Purchase items that do not contain mercury***
- **Implement a phase-out plan for devices that contain mercury***
- **Turn in elemental mercury and items that contain mercury for proper disposal**

* Except fluorescent lamps/bulbs

_____ _____

School Representative Date

_____

Community Partner/Waste Management Representative

School Name _____

School Address _____

Phone _____

Mercury Trivia

1. The amount of mercury in 1 fever thermometer (½ gram) can pollute a body of water what size?
A) 10 acres
B) 20 acres
C) 30 acres

2. How many grams are there in one teaspoon of mercury?

A) 30 grams
B) 60 grams
C) 70 grams

3. True or False: 25 Fluorescent Lamps contain about 1 gram of mercury

4. True or False: More than 2/3 of the mercury in our environment has been introduced as a result of human activities, mostly from burning coal for electricity and burning trash.

5. True or False: Most of the mercury pollution from homes occurs when thermometers are broken.

6. How many chain drugstores have banned the sale of mercury fever thermometers? (Known by Health Care Without Harm as of March, 2002)
    A. 20
    B. 30
    C. 40

7. True or False: If you cook a fish long enough, you can get the mercury out of it.

8. True or False: Over 40 bodies of water in Massachusetts have mercury advisories.

Answers:

1. A
2. C
3. True
4. True
5. False, most mercury pollution from the home occurs as a result of electricity use.
6. A
7. False
8. True