OUTDOOR CLASSROOM SYMPOSIUM

LEAPING INTO

Ten years of Taking Teachers Outdoors

Symposium Resource Guide

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OSC 2006 – Leaping Into Green and Healthy Schools
Charlie Elliott Wildlife Center, Mansfield, GA
Friday, October 27, 2006

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organized by session topics

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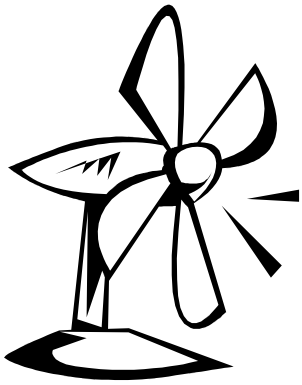

AIR SESSIONS

Materials provided by speakers from the following sessions:

- **Get Your "Hands-On" Air Quality**
  - Exciting New Lessons in Air Quality
  - Better Air Schools
- **Indoor Air Quality Tools for Schools**
  - IAQ Tools for Schools
- **Leap into Cleaner Air: Air Quality, Attendance & Asthma**
  - What is Air Pollution

Exciting New Lessons in Air Quality
Brought to you by The Clean Air Campaign®
Available at CleanAirCampaign.com

4th Grade: Air Quality and Visibility

Hazy Days
To learn more about particulate matter, students play an action game in which cilia try to prevent haze particles from entering the lungs.

Monitoring Air Pollution
Using homemade particulate matter collectors, students collect, observe and analyze particulate matter from various locations around the school.

5th Grade: Air Quality and Transportation

The Six Infamous Air Pollutants
Students research and characterize the six major air pollutants by role-playing each compound at a mock press conference.

Traffic Jams
The ingenious traffic congestion game featured in this lesson allows students to explore how vehicles contribute to air pollution through use of math manipulatives, data collection and graphing.

Green Vehicles
After researching new technologies designed to reduce vehicle emissions, students will create presentations to market those vehicles that feature their favorite air pollution solutions.

6th (or 8th) Grade Earth Science: Air Pollution and Earth Science

Ozone: The Good, the Bad, and the Ugly
To distinguish among ground-level ozone, stratospheric ozone and smog, students will conduct experiments with sunscreen and UV-detecting beads, make and use their own ozone detection strips, and create smog in a jar.

Heat Islands
By measuring the temperature above different types of outdoor surfaces, students will learn about the heat island effect created in urban areas and its relationship to air pollution.

7th Grade: All Choked Up: Air Pollution and the Respiratory System

Every Breath You Take
After learning the parts of the respiratory system, students make a working lung and diaphragm model, then modify it to demonstrate air pollution-induced health effects.

Lung Power and Air Pollution
Students decipher the Air Quality Index (AQI) by analyzing data from pollution monitoring stations, building a device to measure lung capacity, and comparing results between days with good and bad air quality.

8th (or 6th) Grade Physical Science: Elements of Air Pollution

Properties of Air
Students explore the properties of air by building air cannons, heating air-filled balloons, separating hydrogen and oxygen from water, observing air as it is released from plants, and testing air for the presence of carbon dioxide.

Chemistry of Air Pollution
Basic chemistry is fun when students play the interactive computer game Planet Polluto, research various polluting elements and compounds, and simulate chemical reactions in a rousing round of ozone tag.

Better Air Schools
Just the Facts!

What is the Better Air Schools program?

The Clean Air Campaign®'s Better Air Schools program empowers you and your entire school community to make a difference in cleaning up our air!

The program is open to elementary schools in the 20-county metro Atlanta region. The Clean Air Campaign provides promotional materials and giveaways for student and teacher participants, and helps you set goals to ensure success. At the end of the year, schools with the strongest Better Air Schools programs will be recognized with awards.

What can Better Air Schools do?

Better Air Schools must choose a minimum of three projects, all projects work together to educate students and encourage positive changes within your community. Schools can select those that work best for their needs:

- An anti-idling campaign that reduces harmful smog-forming emissions
- A fun, educational musical assembly program that features BAIR, the Better Air Bear
- Air quality lesson plans for grades 4-8. Lesson plans meet Georgia Performance Standards (GPS), and are posted to the Georgia Learning Connections Web site.
- Smog Alert awareness program
- *Ride There! for Clean Air*, a program to encourage bus ridership
- *Walk There! for Clean Air*, a program to encourage walking to school

Why should my school become a Better Air School?

Air pollution affects <u>everyone</u>, especially children. By becoming a Better Air School, you can set a positive example for students and the community. Better Air Schools also empower children to be part of the solution by offering choices that can improve the air they breathe.

The Better Air Schools program can also improve traffic congestion on and around school grounds, helping students arrive on time and ready to start the day, and saving parents time and money.

Better Air Schools receive:

- Free, one-on-one project assistance from The Clean Air Campaign
- Free support materials to implement each specific project and motivate participation
- An opportunity for positive public recognition through our media relations program
- An official Better Air Schools Certificate of Participation, signed by the Governor
- Recognition for your school and giveaways for student and teacher participants

For more information
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United States Environmental Protection Agency

EPA 402-F-03-011

IAQ Tools for Schools

Indoor Air Quality Tools for Schools Program

Step-by-step guidance to improving the air quality in our nation's schools

The Problem

Nearly 56 million people in the United States spend their days in elementary and secondary schools. According to the Department of Education's National Center for Education Statistics, in 1999, 43 percent of America's public schools—about 33,800—reported at least one unsatisfactory environmental condition (i.e., lighting, heating, ventilation, indoor air quality, acoustics or noise control, or physical security of the building). Approximately 25 percent of public schools reported that ventilation was unsatisfactory, while indoor air quality (IAQ) was reported to be unsatisfactory in about twenty percent of schools. Poor indoor air quality can impact the comfort and health of students and staff, which in turn can affect concentration, attendance, and student performance.

Schools that fail to respond promptly and effectively to poor IAQ run the risk of increased short-term health problems, such as fatigue and nausea, as well as long-term health problems like asthma. In serious cases, schools have been shut down and have had to move staff and students to temporary facilities. Delaying remediation of IAQ problems can also be costly and may even lead to liability claims and lawsuits that can damage a school's reputation. Clearly, IAQ issues are best addressed early and better still proactively.

The Solution

The *IAQ Tools for Schools* (*IAQ TfS*) Program is a comprehensive resource that can help you maintain a healthy environment in your school buildings, by identifying, correcting, and preventing IAQ problems. The Kit is provided to schools at no cost and includes easy-to-follow checklists, videos, sample memos and policies, a recommended management plan, and a unique problem-solving wheel. Using the tools in the Kit, school officials can educate staff, students, and parents about the importance of good IAQ and their roles in ensuring a healthy, comfortable learning environment. Armed with the knowledge of good IAQ practices and commonsense preventive measures, schools can address most IAQ problems on their own. After all, ensuring a healthy school environment is an investment in your students and staff.

To learn more about the *IAQ TfS* Kit and other resources available to you, visit EPA's Web site at www.epa.gov/iaq/schools, or order a free Kit by calling the IAQ INFO hotline at (800) 438-4318.

Awards and Recognition

The *IAQ TfS* Awards Program provides incentives and public recognition to schools and school districts that are implementing the Kit. Three award categories are offered: *Great Start*, *Leadership*, and *Excellence*, each honoring schools and school districts as they progress through the various stages of the *IAQ TfS* Kit. Many school districts have been recognized for outstanding achievement and leadership in improving indoor air quality. See our Web site at www.epa.gov/iaq/schools/awards for additional information and applications.

Training and Networking Resources

Learn from the experts! Training and networking resources for schools managing IAQ issues are widely available. The *IAQ TfS* Program sponsors an annual Symposium, internet presentations, and offers specialized training on financing, communications, and facilities maintenance. See www.epa.gov/iaq/schools/index.html for additional information.

What is Air Pollution?

What is Air Pollution?

Air pollution consists of gases, solid particles, and aerosols that change the natural composition of the atmosphere. Some gases that are normal components of clean air, such as carbon dioxide, become dangerous when concentrations are higher than normal. Air pollution has the potential to be harmful to human health and to damage other parts of the environment, including soil and water.

Air pollution can come from two sources: natural and human (anthropogenic). Natural sources can include forest fires, trees and plants, and even sea salt in coastal areas. Anthropogenic pollution occurs from a wide range of human activities, such as car and truck exhaust, industrial processes, power plants, mining activities, and landfills.

What governs air pollution?

The Clean Air Act (CAA) is the federal law that governs air pollution and efforts to improve air quality. The CAA sets standards for how much of certain pollutants can be in the air. These standards are health-based, meaning the amount of pollutants in the air is not supposed to harm human health. The goal of these standards is to ensure that everyone has the same basic health and environmental protections

What pollutes Georgia's air?

Half of all Georgians now live in areas with air that may be harmful to their health. The air pollutants of concern in Atlanta are ground-level ozone and particulate matter.

<u>*Ground level-ozone*</u> (smog): Ozone can be good or bad depending on where it is located. Ozone in the stratosphere high above Earth protects human health and the environment, but ground-level ozone is a serious health concern. Ozone is produced by a combination of two pollutants, nitrogen oxides (NOx) and volatile organic compounds (VOCs), from many sources, including cars and trucks, smoke stacks, paints and solvents, and even trees. These smog-forming pollutants react with one another in the atmosphere in the presence of sunlight to form ground-level ozone.

Ozone levels can vary throughout the day, but the highest concentrations tend to occur between 2 and 7 pm. Ground-level ozone increases throughout the day as temperatures rise. May 1 – September 30 is Georgia's official ozone season, but unhealthy ozone levels can happen anytime there is enough heat and sunlight to form ozone in the atmosphere.
Until 2004, 20 counties in the Atlanta area had been trying to meet the old CAA ozone standard, which is known as the 1-hour standard. In 2004, however, a new, more protective ozone standard, the 8-hour standard, became effective. One of the differences between the two standards is the time period over which the level of ozone in the air is measured (one hour v. eight hours).

Atlanta finally met the 1-hour standard in 2004, but Atlanta, areas around Macon, and an area in Georgia near Chattanooga do not meet the new 8-hour standard. The state is developing plans to bring Atlanta and the other areas into compliance with the 8-hour standard. Atlanta is classified as a "marginal" non-attainment area, which means it is required to meet the standard by 2007. Atlanta will likely not meet this

deadline and will be bumped up to a "moderate" non-attainment area, which will postpone the attainment date to 2010.

Particulate matter (PM): this is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles can be suspended in the air for long periods of time. Some particles are large or dark enough to be seen as soot or smoke. Others are so small that they can only be detected with an electron microscope.

Some particles are directly emitted into the air and come from a variety of sources such as cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood. Other particles may be formed in the air when gases from burning fuels react with sunlight and water vapor. These particles can result from fuel combustion in motor vehicles, at power plants, and in other industrial processes.

In 2005, EPA designated 21 counties around Atlanta as non-attainment for PM. EPA also designated areas around Macon and in Georgia near Chattanooga as PM non-attainment areas. The state is also developing plans to bring these areas into attainment with the standard by 2010.

While ozone violations are typically associated with the hot spring and summer months, unhealthy levels of particulate matter can happen in any time of year.

In addition to public health concerns, particulate matter can corrode metals and building facades, inhibit the growth of plants, and reduce visibility.

Sources: Georgia Institute of Technology, American Lung Association, Clean Air Campaign, U.S. Environmental Protection Agency

Prepared by The Georgia Conservancy, August 2005

Air Pollution Links for Students

http://www.arb.ca.gov/knowzone/knowzone.htm

http://edugreen.teri.res.in/

http://www.energyquest.ca.gov/

http://www.niehs.nih.gov/kids/baylor/homeair.htm

http://www.epa.gov/airnow/aqikids/index.html

http://www.sk.lung.ca/content.cfm/kids

http://www.smogcity.com/welcome.htm

http://www.planetpolluto.com/index1.html

http://www.epa.gov/ozone/science/missoz/index.html

http://www.ozoneactionday.org/kidozone.asp

List prepared by students of Centennial Place Elementary School

General Air Pollution Links

http://www.epa.gov/airnow/

http://www.cleanairstandards.org/

CHEMICAL SESSIONS

Materials provided by speakers from the following sessions:

- **Hazardous Waste 101: Keeping the Classroom Healthy**
- **Green Reactions: Sustainable Science for the Chemistry Lab**
    - Billy's Funny List
    - What Can I Expect in an Inspection?
    - Getting Off to A Safe Start

Billy's Funny List: A "Rule of Thumb" list of hazardous constituents. Compounds and constituents on these lists are hazardous waste and must be handled and disposed of properly, in accordance with the Georgia Rules for Hazardous Waste Management. This is not an exhaustive list.

Metallic constituents include salts and organometallic compounds.

I NEED TO DISPOSE PROPERLY IF NOT IN USE

Excess (more than a couple of years' worth), obsolete (no ZIP code, no CAS number), damaged (no label, parafilm cap) stock of:
Ignitables (flash point less than 140EF/60EC, or difficult to extinguish)
Corrosives (pH less than 2 or more than 12.5)
Reactives (shock sensitive, water reactive, or generates sulfide or cyanide)
Toxics:

Arsenic
Barium
Benzene
Cadmium (BUT see next list)
Chloroform
Chromium
1,2-Dichloroethane
1,1-Dichloroethylene
Lead
Lindane
Methyl ethyl ketone
Nitrobenzene
Pyridine
Selenium
Silver

I NEED TO GET RID OF SOON, AND NOT REORDER
(Students should not be using or handling these, nor should they be used in demonstrations)

Cadmium artist's oil paints (Cadmium Red, Cadmium Orange, Cadmium Yellow)
Carbon tetrachloride
Chlordane
Chlorobenzene
o-Cresol
m-Cresol
p-Cresol
Cresol
2,4-D
1,4-Dichlorobenzene
2,4-Dinitrotoluene
Endrin
Heptachlor (and its epoxide).
Hexachlorobenzene
Hexachlorobutadiene
Hexachloroethane
Mercury and compounds (BUT see next list)
Methoxychlor
Pentrachlorophenol
Tetrachloroethylene
Toxaphene
Trichloroethylene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,4,5-TP (Silvex)
Vinyl chloride

I NEED TO CALL FOR HELP RIGHT NOW

(Some of the acutely hazardous wastes in the "P" list compounds at 40 CFR 261.33)

1-Acetyl-2-thiourea
Acrolein
Aldicarb (Sevin)
Aldicarb sulfone
Aldrin
Allyl alcohol
Aluminum phosphide (R,T)
Ammonium picrate (R)
Ammonium vanadate
Arsenic compounds
Aziridine
Aziridine, 2-methyl-
Barium cyanide
Benzenamine, 4-chloro-
Benzenamine, 4-nitro-
Benzene, (chloromethyl)-
Benzenethiol
Benzyl chloride
Beryllium powder
Bromoacetone
Brucine
Carbaryl (Temik)
Carbofuran
Carbon disulfide
Carbonic dichloride
Carbosulfan
Chloroacetaldehyde
p-Chloroaniline
1-(o-Chlorophenyl)thiourea
3-Chloropropionitrile
m-Cumenyl methylcarbamate
Cyanides and compounds
2-Cyclohexyl-4,6-dinitrophenol
Dichloromethyl ether
Dichlorophenylarsine
Dieldrin
Dimethoate
Dimethylphenethylamine
4,6-Dinitro-o-cresol, & salts
2,4-Dinitrophenol
Dinoseb
Diphosphoramide, octamethyl-
Diphosphoric acid, tetraethyl esterDisulfoton
Dithiobiuret
Endosulfan
Endothall
Endrin, & metabolites
Epinephrine
Ethanedinitrile
Ethyleneimine
Famphur
Fluorine
Fluoroacetamide
Heptachlor
Hydrogen phosphide
Isodrin
Isolan
Mercury, organic compounds
Methanamine, N-methyl-N-nitroso-
Methiocarb
Methomyl
Methyl hydrazine
Methyl isocyanate
2-Methyllactonitrile
Methyl parathion
Metolcarb
Mexacarbate
alpha-Naphthylthiourea
Nickel carbonyl
Nicotine, & salts
Nitric oxide
p-Nitroaniline
Nitrogen dioxide
Nitrogen oxide NO
Nitroglycerine (R)
N-Nitrosodimethylamine
N-Nitrosomethylvinylamine
Promecarb
Propanenitrile
Propanenitrile, 2-hydroxy-2-methyl-
1,2,3-Propanetriol, trinitrate (R)
2-Propanone, 1-bromo-
Propargyl alcohol
2-Propenal
2-Propen-1-ol
1,2-Propylenimine
2-Propyn-1-ol
Sodium fluoroacetate
Strychnine, & salts
Tetraethyldithiopyrophosphate
Tetraethyl lead
Tetraethyl pyrophosphate
Tetranitromethane (R)
Thallic oxideThallium oxide
Thallium(I) selenite
Thallium(I) sulfate
Thiofanox
Thioimidodicarbonic diamide
Thiophenol
Thiosemicarbazide
Thiourea, (2-chlorophenyl)-
Thiourea, 1-naphthalenyl-
Thiourea, phenyl-
Tirpate
Toxaphene
Trichloromethanethiol
Vanadic acid, ammonium salt
Vanadium oxide
Vinylamine, N-methyl-N-nitroso-
Warfarin, & salts
Zinc phosphide
Ziram

Any other organometallic compounds

And any other compound with over twenty letters in the name.

Department of Natural Resources, Environmental Protection Division
For assistance contact Billy Hendricks 404-656-2833 or your county hazmat team.
September 30, 2008

What can I expect in an inspection?

1. Credentials: don't expect a badge - they don't trust us with badges. We are not peace officers certified by the state. Some inspectors will wear a DNR uniform, and will look like game wardens. However, any inspector must provide, upon request, photo identification. They should also be able to provide you with a business card. If you have any reason to doubt their authenticity, call their office. That means you need to know what their office phone number is, independent of what they tell you.

2. Inbriefing: the inspector should sit down with you and your administrator or other people of your choice, and describe what's about to happen. If the inspector or inspectors are there because of a complaint we received, they should tell you. If they don't volunteer that information, feel free to ask. Ask about anything you don't understand.

3. Personnel: there will usually only be one inspector. In some cases, the inspector will bring a trainee, a mentor, or even someone from the USEPA. Occasionally, we conduct multimedia inspections. In these cases, there will be an inspector from each environmental medium for which your facility has a permit or other regulatory burden.

4. Professionalism: you have the right to expect to deal with a civil, knowledgeable, competent professional. This doesn't mean you won't be asked some difficult questions - make sure the person who actually knows the answers is handy. However, if you think the inspector is acting in an unprofessional manner, document it (videotape is fine), put up with it for the duration of the inspection, and then call their supervisor. Okay. Let's go for a walk.

5. Thoroughness: the inspector will likely want to see EVERYWHERE that you manage (generate, accumulate, store) hazardous waste or hazardous materials. Why hazardous materials? To ensure that there are no releases of something which becomes a hazardous waste when it hits the floor. The Rules allow the inspector access to virtually every square inch of the site, at any time hazardous waste management activities are going on, and to sample anything anywhere. The inspector must provide his own sampling supplies and equipment, and must provide you a split (equal portion) of the sample.

6. Point of view: what is the inspector looking for? While we do have inspection checklists, most veteran inspectors don't use one. Most of the provisions of the Rules are based on common sense. As in, Everything I Needed to Know I Learned in Kindergarten. Close what you open. Use up what you can. Don't throw away anything useful. Identify things. Write down what you did. Be nice to people. Your mama doesn't work here, so clean up what you spill.

7. Outbriefing: at the conclusion of the inspection, the inspector should provide you a synopsis of how conditions were. You should set up the outbriefing as a conference with whoever you think needs to hear it. Many facilities try to have the director, principal, garrison commander, or some similar higher-up present. At least arrange to have the head of physical plant present. Most managers with responsibility for environmental and health and safety are interested in grabbing whatever attention they can. The squeaky wheel gets the grease.

8. Documentation: anything you hear from the inspector is only worth the paper it's written on. WRITTEN follow-up must be sent to you in a reasonable time. "Reasonable" depends on how big your facility is, how many samples and photographs the inspector took, whether the secretary is out for the holidays, etc., but should be less than a month. You are not liable for any findings of violation which are not provided in writing.

Billy Hendricks works as an Environmental Specialist in the Georgia Department of Natural Resources, Environmental Protection Division. He began inspecting government facilities in 1958 when he first toured Fort Benning in the back seat of his uncle's Mercury convertible. Born, raised, and educated in Georgia, he took a summer job with the EPD's Water Protection Branch after graduation from the University of Georgia. A year of taking water samples in Water Protection led to eight more in Air Protection, testing and monitoring industrial emission sources and ambient pollutants. Now, thirty-one years after starting that summer job, he is the senior compliance officer in EPD's Hazardous Waste Management Branch. His responsibilities include all facets of hazardous waste regulation, permit writing, compliance auditing, and enforcement for over a hundred government-owned facilities, ranging from the Naval Submarine Base Kings Bay and Georgia State University to the Gwinnett County Public Schools and the Decatur County Industrial Park.

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GETTING OFF TO A SAFE START

Using safer starting materials for chemical reactions

Many industrial chemical processes and laboratories make use of starting materials (reactants) that can be harmful to human health and the environment unless properly handled and stored. If a chemical process uses hazardous substances—for example, those that are highly toxic, harm lung tissue if inhaled, damage skin on contact, or are explosive—there is always the danger that accidents can occur, exposing workers and others to these chemicals or releasing them into the environment. Therefore, green chemistry principles dictate that chemists investigate whether it is possible to reduce the hazards by using safer reactants to produce the same products. A number of chemical companies have made progress in doing this, and others are beginning to look more closely at their processes to reduce hazards. This is particularly important in industrial processes for which very large quantities of chemicals are used. However, even on a smaller scale, safer substitutes might be found for chemicals used in research and student laboratories.

In this module, we will see an example of how to substitute safer chemicals in a process that is typically used in student laboratory courses. A common type of experiment that appears in many laboratory manuals is called a "clock reaction". In such a reaction, a sudden, sharp color change occurs in the solution that contains the reactants when the reaction is complete. Because the sudden appearance of the color makes a striking demonstration, clock reactions are often used in chemical magic shows. In student laboratories, the color appearance also makes it easy to measure reaction time by determining how many seconds pass from the time the reactants are mixed to the time the color change occurs. The effect of changing reactant concentrations or temperature can be studied by measuring how changes in these variables affect the reaction time.

Chemicals such as formaldehyde, mercuric ion, thiosulfates, or bisulfites are typically used in clock reactions. These substances can be carefully handled in the laboratory with special precautions and with safe disposal procedures for chemical waste. However, suppose that ordinary household materials could be used to produce a clock reaction, so that it would pose a lesser risk in the laboratory and would present little risk even in a nonlaboratory situation such as a chemistry magic demonstration for the public or for elementary school students. Although no procedure is totally free of risk, even using consumer-available materials that are generally recognized as safe, the new approach would represent a greener way to demonstrate the same ideas on reaction rates. We will use such a clock reaction in this module.

Green chemistry principle

Get off to a safe start. Identify reactions that use nontoxic/nonhazardous starting materials to make a desired product. This minimizes danger to workers in manufacturing plants when they handle the chemicals and also prevents accidental release of harmful chemicals to the environment if leaks or explosions occur.

Curriculum links

- laboratory safety
- chemical reactions
- rate of reactions

Review the safety guidelines on page iv and the rules of laboratory conduct before beginning these activities.

Activity 1. The vitamin C clock reaction

This experiment, adapted from the January 2002 issue of the *Journal of Chemical Education*,[1,2] is a clock reaction that uses all household materials.

Materials

distilled water	250-mL beakers or plastic cups
1000 mg vitamin C tablets	alcohol thermometer
tincture of iodine (2%)	ice cubes
hydrogen peroxide (3%)	bucket or tub for ice bath
liquid laundry starch	warm water bath

Procedure

1. Make a vitamin C solution by crushing a 1000 mg vitamin C tablet and dissolving it in 60 mL of distilled water. Label as "vitamin C stock solution".
2. Combine 5 mL of the vitamin C stock solution with 5 mL of iodine and 60 mL of water. Label this "solution A".
3. Prepare "solution B" by adding 60 mL of water to 15 mL of hydrogen peroxide and 2 mL of liquid starch solution.
4. Pour solution A into solution B, and pour the resulting solution back into the empty cup to mix them thoroughly. Begin timing as soon as they first mix and continue until there is a color change. Record the time it takes for the color to change.

Activity 2. The effect of concentration on the clock reaction

1. Repeat the experiment, but this time use 30 mL of water when preparing solutions A and B. Time the reaction and record the results.
2. Repeat the experiment, but this time use 90 mL of water when preparing solutions A and B. Time the reaction and record the results.
3. Repeat at other concentrations, as directed by your teacher.

Activity 3. The effect of temperature on the clock reaction

1. Repeat the original experiment using 60 mL of water to prepare solutions A and B, but cool the solutions to 15 °C before mixing by placing the containers in an ice bath. Mix as before, timing the reaction and recording the result.
2. Repeat again, this time using a warm water bath to heat the solutions to 25 °C. Mix as before, timing the reaction and recording the result.
3. Repeat again, this time at room temperature. Record the temperature. Mix as before, timing the reaction and recording the result.
4. Repeat at other temperatures, as directed by your teacher.

Green Chemistry

Preventing pollution.
Sustaining the earth.

Questions

1. What is the difference between the clock reaction and other color-changing reactions that you have done prior to this in your studies?
2. *Rate of reaction* is defined as how fast reactants are used up or products appear. What is the relationship between the time it takes for a reaction to occur and the rate of reaction?
3. What appears to be the relationship between the concentration of the reactants and the rate of this reaction?
4. What appears to be the relationship between the temperature of the reactants and the rate of reaction in this experiment?
5. One of the mercury-based clock reactions used approximately 150 mL of 0.01 M $HgCl_2$ solution per experiment for each lab group (2 students per group). For example, assume that all of the approximately 2 million introductory chemistry students in the nation did the safer experiment described in this activity rather than the mercury-based experiment; how much mercury waste would be avoided?
6. What are the advantages of limiting the use of mercury compounds in lab experiments? What are some of the health and environmental problems associated with mercury? Explain why it is desirable to limit the release of mercury into the environment.
7. Suppose a researcher were doing work on mercury compounds and its use couldn't be avoided. What precautions should be taken when disposing of the mercury compounds? Consult a Materials Safety Data Sheet (MSDS) on mercuric chloride or other mercury compound and note the suggestions for disposal.

Background Information

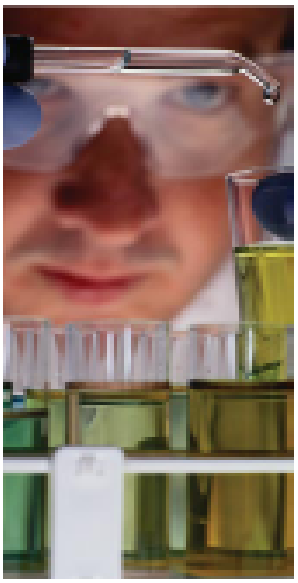
How do we know if a substance is safe or hazardous? Are substances that we call "safe" always safe, or do they pose a risk to health under some conditions? How do we determine risk, and how does risk differ from hazard?

When we consider a substance to be safe, we usually mean it poses little or no risk to us under ordinary conditions of use. The concept of risk—defined as the chance of damage, injury, or loss—actually contains two components: *hazard* and *exposure*. A hazard is a source of potential loss or danger. Examples of hazards are a wet floor, a bridge with a weakened support structure, or some chemicals that are highly poisonous or explosive. A risk is the possibility or the chance that the hazard will cause harm. Determination of risk requires that we take into account our level of exposure to a hazard as well as the hazard itself. If we were to state this as an equation, it would look like this:

Risk = f(hazard, exposure)
(Risk is a function of hazard and exposure).

If you refrain from walking across a wet floor, it doesn't pose a risk to you, even though it is a hazard. In other words, without any exposure to the wet floor, you will not be harmed because of it. To determine how great a risk is posed by chemicals, we must also consider both hazard and exposure. Let's look at an example of this involving the toxicity of substances.

It has been said that "the dose makes the poison"; in other words, a substance may be safe in small quantities but deadly in larger amounts.



"Chemistry has an important role to play in achieving a sustainable civilization on earth."

— Dr. Terry Collins, Professor of Chemistry Carnegie Mellon University

Some chemicals pose intrinsically greater risks than others because they are harmful even at low exposures. One way to evaluate the toxicity of a substance is to study its effect on animals exposed to varying doses. Substances that have lethal effects even at relatively low doses are considered more hazardous than those that are deadly only at a very high dose. Scientists use the term LD_{50} to refer to the dose that is lethal to 50% of the test animals (usually mice or rats). LD_{50} is typically reported in mg substance/kg body weight. The smaller the LD_{50} value, the more toxic the substance. For example, an oral dose of only 6.4 mg of sodium cyanide per kg of body weight is sufficient to cause death in 50% of a population of rats. In contrast, a dose of 29,700 mg/kg of sucrose (cane sugar) or 3000 mg/kg of sodium chloride (table salt) would have to be fed to rats to cause death in 50% of the population.

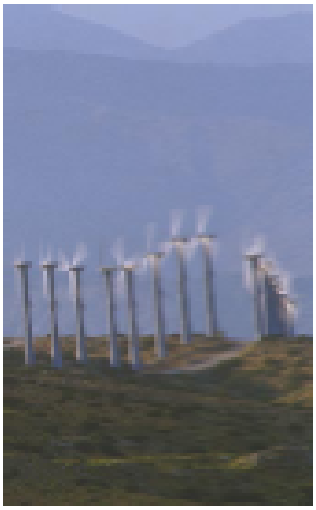
Traditionally, risk management for chemicals has focused on limiting exposure of those who handle them through the use of protective equipment such as gloves, respirators, and fume hoods. These exposure-limiting tools can and do fail. Green chemistry is a much more effective risk management tool because it lowers risk by reducing or eliminating the use of hazardous substances in chemical processes. If substances pose little or no hazard to begin with, then exposure is no longer an issue.

One example of the impact of finding safer starting materials has been demonstrated by the work of Karen M. Draths and John W. Frost at Michigan State University in developing a new way to produce the chemical adipic acid. Very large quantities of adipic acid—$HOOC(CH_2)_4COOH$—are needed every year in the industrial production of nylon-6,6, polyurethane, lubricants, and plasticizers. The typical starting material for making adipic acid is benzene, a cancer-causing agent. In a process aided by biocatalysis (genetically altered bacteria), Frost and Draths have produced adipic acid starting from glucose, a simple sugar found naturally in plants, rather than benzene. Starting with a safe substance like glucose to make adipic acid means that the use of large quantities of benzene can be avoided if new processes such as this one become widely used.

What is a sustainable civilization? We will consider this question from these viewpoints:

The environment and human health.

A stable economy that uses energy and resources efficiently.



Instructional notes

Instructional notes on activity 1. The vitamin C clock reaction

This lab is presented as an example of green chemistry. It introduces an alternative way to do a traditional lab, using safer starting materials. Since your students are new to chemistry, they will not have any experience with the "old" ways. You will need to put this lab into perspective for them by reviewing the older versions of this experiment and discussing what was so bad about them. You might want to do a calculation similar to question 5, only dealing with the amount of formalin used in the formaldehyde clock reactions. (See Reference 2 for this demonstration.)

Although this activity is very popular with students, there are some issues to deal with when you use it in your class. One of the key issues is explaining what is going on in the reaction.

Part of the reaction is easy to explain. When iodine and starch combine, they make a black-blue complex. Students will probably recognize this from their biology class, where iodine is used as a test reagent for starch. The reaction rate being studied is for the following reaction:

$$2H^+_{(aq)} + 2I^-_{(aq)} + H_2O_{2(aq)} \rightarrow I_{2(aq)} + 2H_2O_{(l)}$$

The I^- is produced by adding excess vitamin C (ascorbic acid $C_6H_8O_6$) to household tincture of iodine.

$$I_{2(aq)} + C_6H_8O_{6(aq)} \rightarrow 2H^+_{(aq)} + 2I^-_{(aq)} + C_6H_6O_{6(aq)}$$

When the H_2O_2 is added to the first reaction, it begins to produce I_2. But since the ascorbic acid reacts with the I_2 immediately, it prevents the I_2 from reacting with the starch. The color change occurs only after all the vitamin C is used up. Another issue to talk about is what is meant by the term rate. Chemists measure rates of reaction in terms of the rate of appearance of a product or the rate of disappearance of a reactant.

Another issue is that students are measuring time in this lab, rather than rate. The rates would actually be proportional to 1/T. It is important to convey that as the reaction time gets smaller, the rate is actually larger. If this distinction is not made, students might be thinking the reverse of the proper relationship. It should be noted that this experiment only approximates an authentic rate of reaction. Since the color-change reaction that we are actually seeing is distinct from the reaction rate we are studying, we are only approximating the actual rate. Despite this minor shortcoming, the lab gives students a good concept of rates of reaction.

Instructional notes on activity 2. The effect of concentration on the clock reaction

By lowering the concentration of the reactants (using more dilute solutions), the rate of reaction tends to decrease. If there are fewer molecules in a given volume of solution, then it is reasonable there would be fewer effective collisions and fewer products formed.

Note that the quantitative change in reaction rate brought about by a change in concentration involves a complex interaction. Advanced-level courses consider reaction order and how the reaction mechanism affects rate.

A related extension would be to have students calculate the effect of mixing on the rate of reaction. Students could experiment with different ways of combining the solutions, varying the amount of mixing that occurs.

Instructional notes on activity 3. The effect of temperature on the clock reaction

Be sure to arrange appropriate hot and cool water baths in advance. It is usually easier to set up some central water baths and have all students use them. If you do not have a dedicated water bath, you can always improvise by placing a water-filled metal pan on a hot plate. You will need to replenish the water in these baths during the day. Alternatively, you can have students create their own water baths by using a large beaker at their lab station. Consider grouping students, giving each group a different temperature range to try.

Answers to questions

1. What is the difference between the clock reaction and other color-changing reactions that you have done previously in your studies?

   The big difference is that most reactions used in chemistry classes tend to change immediately. This experiment uses a combination of reactions, with the final reaction marking when the reaction series is completed. The analogy is that it is like an alarm clock. The clock runs for a time, and then the alarm sounds. The running clock is like the first reaction above, the "alarm" is like the combination with starch.

2. *Rate of reaction* is defined as how fast reactants are used up or products appear. What is the relationship between the time it takes for a reaction to occur and the rate of reaction?

   The rate is the amount of substance reacting per unit of time. Thus the faster (smaller number) the reaction time, the greater (bigger number) the rate.

3. What appears to be the relationship between the concentration of the reactants and the rate of this reaction?

   The higher the concentration, the greater the rate of reaction. It should make sense that higher concentration means a greater number of collisions and a greater possibility of effective collisions.

4. What appears to be the relationship between the temperature of the reactants and the rate of reaction in this experiment?

   The higher the temperature, the greater the rate of reaction. In this reaction, a higher temperature means greater kinetic energy in the particles and a higher proportion of effective collisions (collisions that lead to reactions). Also, with greater kinetic energy, more collisions will occur.

5. One of the mercury-based clock reactions used approximately 150 mL of 0.01 M $HgCl_2$ solution per experiment for each lab group (2 students per group). For example, assume that all of the approximately 2 million introductory chemistry students in the

nation did the safer experiment described in this activity rather than the mercury-based experiment; how much mercury waste would be avoided?

This calculation entails a lot of "what ifs". If 150 mL of solution is used for each pair of students, then

$$2.0 \times 10^5 \text{ students} \times \frac{0.150 \text{ L}}{2 \text{ students}} \times \frac{0.01 \text{ mol}}{1 \text{ L}} \times \frac{271.6 \text{ g}}{1 \text{ mol}} = 407{,}400 \text{ g}$$

This assumes that every classroom in the United States is doing this experiment, which is unlikely. Nevertheless, this single modification would save about 900 pounds of mercury from being used.

6. What are the advantages of limiting the use of mercury compounds in lab experiments? What are some of the health and environmental problems associated with mercury? Explain why it is desirable to limit the release of mercury into the environment.

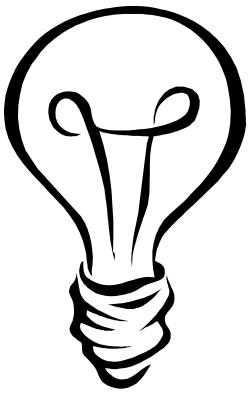
   Elemental mercury is used in hundreds of applications, from electrical switches to street lamps. If mercury gets into the bloodstream and into the brain, it can cause serious damage to the central nervous system. Young people are particularly susceptible to this type of damage. Most mercury pollution is released through the burning of coal and waste incinerators. The dangers of long-term accumulation of mercury in the environment have led to the elimination of most industrial contributions of mercury waste.

7. Suppose a researcher were doing work on mercury compounds and its use couldn't be avoided. What precautions should be taken when disposing of mercury compounds? Consult a Materials Safety Data Sheet (MSDS) on mercuric chloride or another mercury compound and note the suggestions for disposal.

   Elemental mercury is not very toxic. Damaging effects occur when it crosses the blood–brain barrier. The compounds of methylmercury are far more toxic. Flinn Scientific suggests that mercury compounds can be safely disposed of by converting them to an insoluble salt and placing them in an approved hazardous materials landfill. Flinn advises that the only safe disposal of mercury metal is to return it to a supplier for recycling.

References

1. Wright, Stephen W. The Vitamin C Clock Reaction. *J. Chem. Educ.*, January 2002, 79 (1), 41–43.
2. Wright, Stephen W. Tick Tock, a Vitamin C Clock. *J. Chem. Educ.* 2002, 79, 40A–40B.
3. Shakhashiri, B. Z. *Chemical Demonstrations*, Vol. 4; University of Wisconsin Press: Madison, WI, 1992.



ENERGY SESSIONS

Materials provided by speakers from the following sessions:

- **How to do a School Energy Audit with Students**
  - Save Money and Energy
- **Energy Education with the NEED Project**
  - Who, What, Why, How
  - The Steps in a NEED Program
- **Learn Math, Learn Science, Save Energy**
  - Green Schools Program
- **Green Building Benchmarking is "Worth" Leaping into…Discover the Benefits of LEED**
  - 10 Reasons Why Teaching about Energy is Essential
  - Energy Saving Activities for Schools
  - Resources on Energy Education & Green Building for Schools

SAVE MONEY AND ENERGY

Energy Efficiency

HOW TO SAVE MONEY
and save energy.

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A SOUTHERN COMPANY

SAVE MONEY AND ENERGY

Home Energy Efficiency

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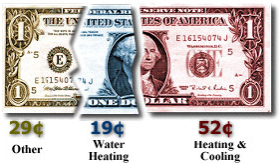
SAVE MONEY AND ENERGY

Where Your Energy Dollar Goes

52 Cents For Heating & Cooling

19 Cents For Water Heating

29 Cents For Other Energy Users



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SAVE MONEY AND ENERGY

Ways to Reduce Heating & Cooling Costs

Change Filters Monthly

Properly Seal All Ductwork

Make Window Improvements (caulk & weather strip)

Set Your Thermostat To 78º F in Summer & 68º F in Winter.
Then leave it there.

Install Programmable Thermostats
Insulate your Attic & Walls

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Insulation Recommendations

Attic	- R30
Wall	- R13
Floor	- R19
Basement	- R5
Slab	- None

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SAVE MONEY AND ENERGY

Window Improvements

Fact:
The glass areas of your home can "let in" 20 - times more heat in the summer and "let out" 15 - times more heat in the winter as the same area of insulated wood-frame wall.

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SAVE MONEY AND ENERGY

Window Improvements

- Caulking Windows
  Reduce Or Stop Air Flow
- Weather-Stripping
  Reduce Or Stop Air Flow
- Storm Windows
  Create Dead Air Space Or Thermal Break
- Plastic Storm Windows
  Create Dead Air Space Or Thermal Break
- Install Curtains or Blinds
  Prevents Drafts, Minimizes Solar Gain

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SAVE MONEY AND ENERGY

Heating & Cooling System Tips

Adjust Your Thermostat & Then Forget It!

- During The Summer, Try Setting The Thermostat At 78º F Or Above.
- In The Winter, Try Setting The Thermostat At 68º F Or Below.
- Every degree raised in the summer and lowered in the winter reduces your heating and cooling costs by 3% - 5%.
- Using a Programmable Thermostat to Adjust Thermostat Settings While You Are At Work Can Reduce Your Heating & Cooling Costs by 20%.

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SAVE MONEY AND ENERGY

Reducing Your Water Heating Costs

Your Water Heater Is The Second-Largest Energy User In Your Home. By Insulating Your Electric Water Heater And Using Hot Water Efficiently, You Will Save Energy And Money Each Month.

19 Cents

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SAVE MONEY AND ENERGY

Tank Losses for Conventional Water Heaters

Electric 50 Gal.

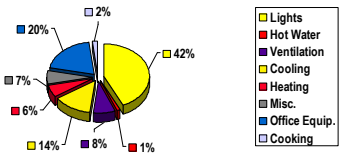
Insulation Type	Delta T	Heat Loss	BTUH Loss	Annual kWh	Annual Cost @ $0.08/kWh
Uninsul.	60	0.037	924	2372	$190
Insul.	60	0.01	250	642	$51

Gas 50 Gal (50% seasonal efficiency)

Insulation Type	Delta T	Heat Loss	BTUH Loss	Annual therms	Annual Cost @ $1.20/therm
Uninsul.	60	0.074	1848	162	$194
Insul.	60	.02	500	44	$53

SAVE MONEY AND ENERGY

Office Energy Use



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SAVE MONEY AND ENERGY

A Sample Lighting Retrofit

50 fixtures – 4 lamps, T-12, 34 watts per lamp w/ magnetic ballasts. (Approximately 158 watts per fixture)

Retrofit To:
50 fixtures – 4 lamps, T-8, 32 watts per lamp w/ an electronic ballast. (Approximately 104 watts per fixture)

Energy Use Calculation:
50 fixtures x (158w – 104w) x 6000 Hours per Year / 1000 watts/kW = 16,200 kWh

Energy Savings: 16,200 kWh x $.035 per kWh = $567.00
Demand Savings: 2.7 kW x $14.07 per kW x 12 Mos. = $456.00
Estimated Annual Total Savings: $1,023
Cost to retrofit each fixture $60. Cost difference between new fixtures $14
Retrofit Payback = $3,000.00 / $456.00 = 6.5 Years,
New Installation Payback = $700 / $456 = 1.5 years

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SAVE MONEY AND ENERGY

Reducing HVAC Costs

- When replacing HVAC equipment install lowest kW per Ton.
  - The highest EER
  - The highest COP
- Conduct regular maintenance on HVAC equipment and controls.
- Use variable speed drives & premium efficiency motors.
- Variable speed drives can save between 25% - 40% of air handler and cooling tower energy costs.

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SAVE MONEY AND ENERGY

Water Heating Tips

- Insulate Your Electric Water Heater With A Water Heater Jacket
- Turn Down Water Heater Thermostat. A Setting of 120º F is Adaquate for Most Home Use.
- Equip Your Shower With A Flow Control Or Regulator And You Can Reduce The Volume Of Water by ½.
- Repair Dripping Faucets

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SAVE MONEY AND ENERGY

Commercial Energy Efficiency

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SAVE MONEY AND ENERGY

Lighting Efficiency

- Retrofit fixtures using T-12, 34-watt lamps and magnetic ballasts with T-8, 32-watt lamps and an electronic ballast and reduce up to 32% of energy costs.
- Retro-fit standard 400-watt metal halide fixtures with 320-watt pulse start lamps and electronic ballasts and save 25% of lighting costs.
- Replace incandescent lamps with compact fluorescent lamps.
  - CF's use 2/3 less electricity
  - CF's last 5 times longer than incandescent lamps
- Retrofit exit signs with LEDs. LED's last 25 years.
- Install occupancy sensors.
- Turn off lights in occupied areas & at night.

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SAVE MONEY AND ENERGY

Reducing HVAC Costs

- Installing a programmable thermostat and setting the night temperature to 80 °F in summer and 65 °F in winter can reduce HVAC energy by 15%.
- Raising the cooling set-point 1 °F during occupied periods reduces cooling energy by 3%.
- Use Outside Air Economizers whenever possible.
- Minimize outside air. Check your ventilation requirements.

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SAVE MONEY AND ENERGY

Additional Information

Visit Georgia Power's Website For More Energy Efficient Information:

GeorgiaPower.com

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WHO: Anyone who works with K-12 students and wants to help them complete the Georgia Green and Healthy Schools assessment on ENERGY.

WHAT: The National Energy Education Development Project (NEED) is a nonprofit education association with twenty-six years of experience in energy education and curriculum development.

NEED works with the education community and the energy industry to design and distribute comprehensive, objective, hands-on, inquiry-based educational materials.

NEED materials are designed to meet the diverse needs and learning styles of students. They are teacher-tested to ensure success in the classroom and are correlated to the National Science Education Content Standards and to state standards.

WHY: The NEED Project is dedicated to promoting a realistic understanding of the scientific, economic and environmental impacts of energy, so that students and teachers can make educated energy decisions.

NEED curriculum energized, motivates and inspires both students and teachers. It provides comprehensive, objective information on all aspects of energy through innovative, relevant, hands-on activities that challenge students to think about their world in a new was.

NEED's *Kids Teaching Kids* approach give students the skills and opportunities to engage their communities in extended learning, leading to a better understanding of the impacts of our daily energy choices.

HOW: NEED conducts student and teacher training programs, provides evaluation tools, and recognizes outstanding student achievement for grades K – 12.

This presentation will provide participants the opportunity to learn how NEED can help students as they work towards completing their school's Green and Healthy Schools self-assessment on ENERGY.

Participants will experience hands-on activities included in NEED's basic program and activities in our energy management kits. You'll learn how simple behavioral changes can help schools achieve Green and Healthy status in ENERGY.

The Steps in a NEED Program

GETTING STARTED

Select the grade level-appropriate activities you will use for steps one through seven according to the diagram on page 4 and the detailed information in this booklet. Complete the order form provided by your workshop presenter or on page 23 of the NEED Resource Catalog and send to NEED.

STEP ONE: SCIENCE OF ENERGY

Students need to learn the science of energy before they can learn about the sources of energy, electric power production, and energy conservation and efficiency. Students learn the forms of energy (heat, light, motion, sound, electricity) and how energy is transformed from one form into other forms. Secondary students can extend their knowledge to thermodynamics. Several hands-on kits are available for sale or rental, such as the Primary, Elementary and Secondary **Science of Energy Kits, EnergyWorks**, and **ThermoDynamics.** In many areas, rental kits are available free of charge. Call NEED Headquarters at 1-800-875-5029 or ask your workshop presenter about availability in your area.

STEP TWO: SOURCES OF ENERGY

These materials give students an understanding of the energy sources used today—their formation, exploration, production, distribution, consumption, and economic and environmental trade-offs. **NEED Infobooks** provide comprehensive information on the major energy sources at four reading levels. Class sets of infobooks are available.

STEP THREE: ELECTRICITY

These materials provide students with information and hands-on explorations of the scientific concepts of electricity and electricity generation, transmission, and efficient use of electricity. **NEED Infobooks** provide background information on electricity. An **ElectroWorks Kit** with Teacher and Student Guides is available.

STEP FOUR: TRANSPORTATION FUELS

Students learn about the transportation sector of the economy, conventional and alternative fuels, and fuels of the future.

STEP FIVE: ENERGY EFFICIENCY AND CONSERVATION

Students learn how energy is used, new energy efficient technologies, and ways to conserve energy at home and at school. School Energy Surveys and **Energy Management Kits** are available for all grade levels.

STEP SIX: SYNTHESIS, REINFORCEMENT, EXTENSION

There are many hands-on activities available to reinforce, synthesize, and extend the information the students have learned. Also available are activities for students to teach others what they have learned.

STEP SEVEN: EVALUATION

Most NEED activities contain evaluation strategies. This blueprint contains a **Unit Exam** with multiple choice questions and essay questions that require students to draw upon their knowledge of energy to write an explanation or suggest a plan of action and can be done in teams and/or individually. The **Energy Polls** are additional evaluation tools included in this booklet.

STEP EIGHT: RECOGNITION

The **Youth Awards Guide** (in **Projects and Activities)** gives you all the information you need to document your energy activities in a scrapbook and to participate in the Youth Awards Program for Energy Achievement.

ALLIANCE TO SAVE ENERGY
Creating an Energy-Efficient World

Fact Sheet

Green Schools Program

OUR GOALS

The Alliance to Save Energy's Green Schools Program has three primary goals:

- to educate students, teachers, facilities staff, administrators, and the whole school community about energy efficiency and its ties to finances and the environment;
- to provide immediate energy savings in schools through no-cost behavior and operations changes, and longer term savings by encouraging school retrofits; and
- to strengthen student academic learning using hands-on, project-based instruction and tools.

In addition, Green Schools engages students as advocates for energy efficiency improvements in their homes and communities. Typically half of the money a school saves from the no-cost initiatives of the students, custodian and teachers is returned to that school to recognize their hard work and provide motivation to continue saving energy; the rest of the money is retained at the district level.

KEY COMPONENTS

1. Energy Efficiency Education
   - The Green Schools Program provides a broad range of instructional materials on energy, the link between energy and the environment, and the practice of using energy efficiently at school and at home. The materials are organized by grade level and topic, and are correlated to state standards of learning. Teachers may select the materials that fit best into their lesson plans.
   - The program engages students in hands-on, experiential learning. Project-based activities help students learn to define a problem, conduct active research to identify potential solutions, and apply the knowledge they gain to achieve energy savings.

2. Energy-Saving Team
   - The Program is implemented by a team of teachers, students, facilities staff, and administrators in each school.
   - Teams participate in an initial one to two-day workshop, in which they work together to create a customized energy-saving plan that is specific to their school and their own needs. The plan includes four "strands," or areas of focus: integrating energy efficiency topics into classroom instruction, implementing energy-saving measures at school, involving the school-wide community, and bringing the energy efficiency message into the home and community.

3. Measurable Results
   - The Green Schools Program has documented that simple daily energy efficiency practices can add up to significant long-term energy and dollar savings. Schools typically achieve savings averaging between five and 15 percent on electricity usage.

GREEN SCHOOLS LOCATIONS

The Program currently has participants in over 200 schools in California, Maryland, New Jersey, New York, North Carolina, Pennsylvania, and Washington, DC and has had international programs in India, Ghana, and Serbia. Several other sites are in various stages of development.

GREEN SCHOOLS SUCCESS

Everyone Benefits from Green Schools:

- Students benefit from hands-on, real-world lessons and leadership opportunities, as well as knowledge that will pay off now and in the future;
- Schools benefit from considerable cost savings, curriculum support, cross-functional team building, and community involvement;
- Communities benefit from the partnerships established among key stakeholders and more affordable energy; and
- The environment benefits from lower levels of emissions.

Examples of Green Schools Success:

- Hands-on instruction: At Bemis Elementary in Rialto, California, students learned firsthand about the effects of colors on the absorption of energy. After testing their hypothesis that the color white would absorb the least energy, the students then made a recommendation to their school board to change the color of the roof to reduce air conditioning costs. The result—Bemis now has a white roof!
- Energy saving action: Students at Wilson High School in Rochester, NY, saved over $20,000 in avoided electricity costs during for the first half of the school year by undertaking various measures, including plastering the school with light-switch notes, promoting energy-efficient juice machines, and working with custodians and teachers to ensure that building lights were left on only when necessary.
- Educating others: Students at Frankford High School of Philadelphia, PA, took their newfound energy expertise to the Delaware Valley Green Building Council's "Building the Town Green" conference, where they taught visitors the proper way to install weather stripping around openings in the building shell and helped them practice their technique with a caulk gun.

The Alliance to Save Energy is happy to share our experience and resources for school-wide energy efficiency. For more information on the Alliance, Green Schools Program, and our other initiatives, please call (202) 857-0666, or visit our website at www.ase.org/greenschools.

10 Reasons Why Teaching about Energy is Essential*

1. Energy use affects us all-our pocketbooks, our environment, and even our national security. Many Americans don't realize that we're now importing more oil than we did during the oil crisis of the late 1970s. And the use of fossil fuels for energy contributes significantly to air pollution.
2. Educating the public, including students, about the economic and environmental costs of energy use is one of the best ways to help curb energy waste.
3. It's important for students to learn about their energy choices along with the advantages and disadvantages of each choice. For example, fossil fuels are convenient and readily available, but their supplies are finite and their use is environmentally damaging. Meanwhile, renewable energy sources are inexhaustible with many environmental benefits, but they aren't necessarily as convenient, readily available, nor able to meet all our nation's energy needs.
4. Chances are that most students have never seen a solar car or a modern, working wind machine. The good news is that interest in the development of renewable energy sources is spreading rapidly once again. Today, as a result of the 2000 California energy crisis and growing concern over global warming, national security and the health effects of poor air quality, renewable energy is gaining the attention of the general public as well as our state and national governments.
5. Helping students understand all aspects of a particular energy source-its availability, benefits, and monetary, environmental, and social costs-will help them make informed decisions about energy at home and at work.
6. Students who can make energy smart decisions will be more conscientious about wasting energy in their lifetimes. For example, the amount of energy wasted through poorly insulated windows is equivalent to the oil pumped through the Alaskan pipeline each year. They can learn that preventing energy loss is often very simple, can save money, and in many cases, can benefit the environment by reducing pollution and conserving our natural resources.
7. Implementing energy efficient lesson plans at an early stage of a child development will provide long term benefits such as increased awareness and lower energy usage over time.
8. Studying energy is an excellent way to introduce students to science concepts and processes included in the National Science Education Standards.
9. Enables teachers to learn about the energy efficient innovations and integrate news about new emerging technologies into their curriculum.
10. The study of the efficient use of energy has not yet received the recognition that it deserves in school science. New approaches, that are readily digestible by students is needed to ensure they are kept interested and fully engaged to learn more about energy efficiency solutions.

**from Energy Smart Schools website – 2006*

Energy Saving Activities for Schools*

Involve the whole school including services in a year-long program of behavior change initiatives so that everyone helps to save energy. (Services are: food service, main office, nurse, counselors.)

Involve outside organizations (such as colleges, businesses, non-profit organizations) in the school energy efficiency effort. Involvement would be presentations, tours, funding, materials, assistance, promotion, or programs.

Create science fair-type projects (experiments or demonstrations) based on school energy efficiency and enter them in a science fair.

Make presentations on school energy efficiency to the PTA/PTO, the school board and/or the superintendent/school district administration.

Have your students teach other kids what they have learned about energy, environment, and saving energy.

Develop energy information through the arts and present to an audience.

Create an educational display for your school on energy, efficiency, and/or environment**.**

Track monthly energy savings or classroom behavior changes. Post them in a common area at school.

Develop energy saving tips for the school newspaper, weekly bulletin, or PA system.

Correspond with pen pals about energy, environment, and efficiency. You may use email or regular mail.

Write an article for the local paper on your Green Schools project.

Interview local energy professional(s) and publish the interview(s) in a school or local paper.

Create a survey on energy awareness and administer to people in your school.

Design and build a model of an energy-efficient building or a component of an energy-efficient building for public display and/or for public presentations.

Do a "walk-through" energy audit of the school. Make a list of suggestions for saving energy in the building.

Take home information about using energy efficiently. Use the school newsletter, the PTA/PTO or another organization for families.

Organize an energy patrol to encourage people to change energy-using behavior at school and to monitor the school's progress toward behaving in new ways when using energy.

Develop an energy efficiency manual specific to your school or for another building that students have audited.

Research the options for increasing the energy efficiency of school windows, doors, lighting or food service. Define the problem, list the options, and include information about costs. Then note which option(s) the team recommends and why.

Landscape school for energy efficiency. Plant appropriate plants in appropriate sites to increase the building's energy efficiency.

Complete a "walk-through" energy audit of student homes.

Make a list of energy problems in the home and suggest solutions.

Each student talks about it with his or her family and makes a plan to change the family's energy-using behavior.

Give several hours of environmental service or community service related to energy/environment.

Organize and present an energy conference, energy festival or energy workshop for the rest of the school or for the community.

Help to build an energy-efficient building, a greenhouse, or a component of an energy-efficiency system (for example, a daylighting retrofit).

Do a "technical" energy audit of the school (using actual data and calculating losses, savings, etc.).Include a list of suggestions for saving energy in the building.

Create your own Web site. The site should teach about energy efficiency and the environment.

Use the EPA benchmarking tool to rate your school. The ENERGY STAR® Benchmarking Tool is an online tool that evaluates building energy performance on a 0 to 100 scale using detailed data on your building's physical attributes, operating characteristics, and monthly energy consumption. http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

Establish a Student Advisory Council or environmental club. SACs or clubs should take an active role in the Program and are responsibility for designing and implementing energy-related programs in the school and community.

Submit an article to the Green Schools Gazette – the newsletter by and for students.

**from Alliance to Save Energy Website- 2006*

Resources on Energy Education and Green Building for Schools:

1 http://www.southface.org

Southface promotes sustainable homes, workplaces and communities through education, research, advocacy and technical assistance. Southface is an affiliate of the US Green Building Council, is an Energy Star Partner, has administered the Energy Smart Schools program in Georgia, and is co-founder and administrator of the EarthCraft House program. The Southface Commercial Green Building Services team works with commercial building owners, designers, and constructors to build and operate healthier buildings that save energy, water and resources.

2 http://www.energystar.gov/index.cfm?c=k12_schools.bus_schoolsk12

Energy Star website includes strategies on energy management, benchmarking tools, and information on Energy Star label products.

3 http://www.usgbc.org

The US Green Building Council is the organization that maintains the LEED program. The website acts as a Green Building clearinghouse of resources.

4 http://www.energysmartschools.gov/

Energy Smart Schools is a Department of Energy / Rebuild America initiative that promotes energy conservation, use of best energy technologies and saving money on energy in schools. Energy education resources are included on the website.

5 http://www.ase.org/section/program/greenschl

The Alliance to Save Energy administers the Green Schools Program– a curriculum-based program that educates students and benchmarks school performance on energy improvements.

6 http://www.energyhog.org/adult/educators.htm

Energy Hog is division of the Alliance to Save Energy. For school teachers and children, they have a fun website containing games, an energy audit checklist, worksheet, etc.

7 http://www.fsec.ucf.edu/ed/k12_teach_rsrc/curric.htm

The Florida Solar Energy Center maintains a website loaded with information and curriculum on solar power for various grade levels.

8 http://www.eia.doe.gov/kids/

The Energy Information Administration is a division of the Department of Energy and maintains a website with activities, curriculum, games, and resources for kids of all ages.

IPM SESSIONS

Materials provided by speakers from the following sessions:

- **"Leaping, Flying and Crawling into… Learning about Pests"**
  - Create An Insect

Create an Insect

Creative Module #4 - Write & Draw

Subjects:

art
language arts
science

Time:

Preparation: **10 minutes**
Teaching: **40 minutes**
Evaluation: **2 minutes/student**

Vocabulary:

temperature
camouflage
adaptation
environment
survival
carnivore
herbivore
omnivore
nocturnal
diet
landforms

More Ideas:

Modifications and more ideas are located at the end of this lesson.

More Information:

www.orkin.com
www.mnh.si.edu
www.insectsafari.com

Skills

Creative writing, research, reading, understanding the parts of an insect

Objective

To demonstrate their knowledge of insects and their characteristics, each student will create a unique insect. Students will write descriptive paragraphs about their creations, noting any special features or adaptations.

Materials

- "Insect Equipment" handout for each student
- "Create an Insect" activity sheet for each student
- paper and pencil to begin, then anything goes!
- pictures of insects and other arthropods (optional)
- insect resources (see attached bibliography)

Background

Insects have a hard outer shell (or skeleton) we call an exoskeleton. Their bodies are divided into three main sections (the head, thorax, and abdomen). They have 6 legs (3 pairs), 2 antennae, and 2 eyes. Many insects have wings. Some insects have simple eyes, although many have compound eyes. Examples of insects are: Beetles, ants, flies, mantis, and grasshoppers. Insects belong to a group of animals called arthropods. Some arthropods don't have what it takes to be an insect. Crustaceans (crabs, lobsters and shrimp), arachnids (spiders, scorpions, and mites), millipedes, and centipedes are arthropods but they are NOT insects.

Insects have adapted in certain ways to increase their chances of survival in the wild. An adaptation is a special skill or characteristic that helps an animal survive in its environment. An adaptation may help an animal hunt, hide, or attract a mate. In this creative module students will explore the primary rules of what an insect is and the adaptations that make each insect unique as they create their own special insect.

Lesson

Pass out the "Insect Equipment" handout to each student. Discuss the standard and optional equipment that make up insects. Share information about other arthropods with students. Display the pictures of insects to the class. Ask them to identify the insects and point out the "standard" or "optional" equipment of each insect.

When students seem familiar with the primary rules of what an insect is introduce the concept of adaptation. Ask students to identify various characteristics that animals (especially insects) can use to help them hunt, hide, or attract a mate. Identify adaptations on the pictures of insects used in the previous part of the discussion. Allow students time to look through the resources about insects to discover other kinds of adaptations.

Distribute the "Create An Insect" activity sheet. Tell students their assignment will be to use their creative skills to design a new insect. Their insects must include all the standard parts of an insect and may include some optional parts.

Using the questions in the handout, have students think of adaptations their insects might have. The adaptations will be determined by the answers to the questions on the activity sheet. For example, if the student's imaginary insect lives in the arctic, it will have adaptations that help it survive the cold.

After they have completed their activity sheets have students write a rough draft of a paragraph describing their insects on the back of their activity sheets. They may also want to sketch pictures of what their imaginary insects look like. When students are ready have them create finished drawings of their insects (you might want to make various art supplies available at this point) and final versions of their paragraphs. Display the drawings and paragraphs on a class bulletin board about insects.

Evaluation

Review each student's activity sheet, paragraph, and drawing. Make sure each student created an insect that has all the standard equipment of an insect and has adaptations suited to its environment.

More Ideas

Allow students to make models of their insects using materials such as clay, plaster, wood, papier maché, pipe cleaners, and tissue paper.

Have students draw or create models of their insects' environment, depicting their homes.

Write creative stories or draw cartoons using their imaginary insects as main characters.

Modifications

Beginning:
Have students work through the activity sheet in small groups or with an adult helper. Then, have each student illustrate the insect created by the group.

Advanced:
Have students develop their ideas further by designing a food chain for their insects. Have students include plants that have adapted to their insect's environment in their drawings. (Also see More Ideas)

National Science Education Standards

The student should develop the ability to understand and to do scientific inquiry.

The student should develop an understanding of the characteristics of organisms and their environments.

Activity Sheet

Create an Insect

NAME ..... DATE .....

1. This is my insect's habitat (where my insect lives):

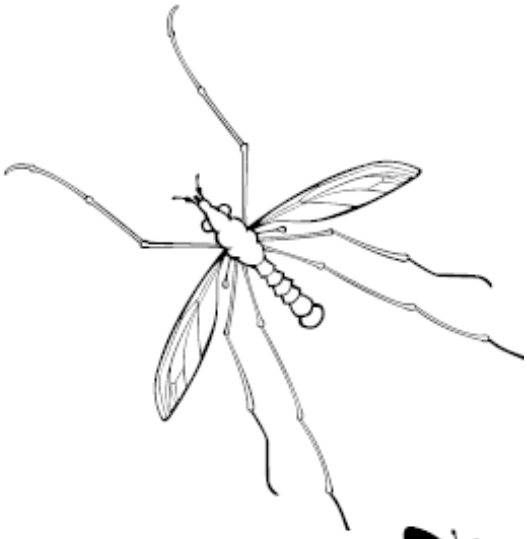
2. This is how my insect moves:

3. This is what my insect eats:

4. This is how my insect eats:

5. My insect is eaten by:

6. My insect avoids its predators by:

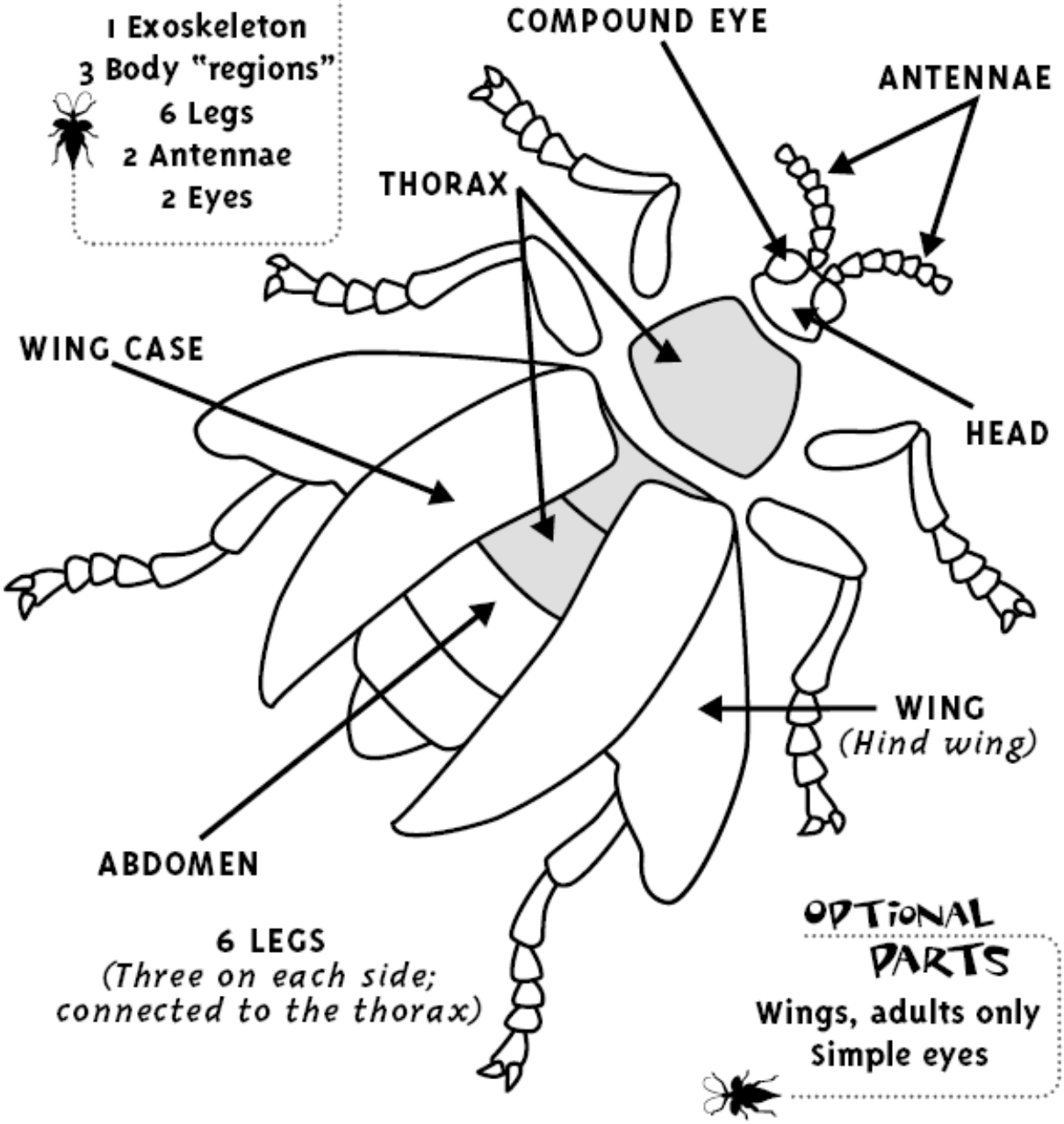


Handout

INSECT EQUIPMENT

STANDARD PARTS

1 Exoskeleton
3 Body "regions"
6 Legs
2 Antennae
2 Eyes



OPTIONAL PARTS

Wings, adults only
Simple eyes