LESSON 9: UNHAPPY ABOUT HAPS

AIR & WASTE MANAGEMENT ASSOCIATION

OBJECTIVES

Students will do the following:

1. Define "HAPs"
2. Describe the health effects of some common HAPs
3. Collect and disseminate information about the HAP content of common household items and products

TOPICS:
Hazardous air pollutants and their effects

SUBJECTS:
Chemistry, biology, language arts, human physiology, environmental awareness

TIME:
2-3 class periods

MATERIALS:
Student handouts

BACKGROUND MATERIAL

Hazardous Air Pollutants, or HAPs, are toxic pollutants that are either known or suspected to cause cancer and/or other serious irreversible or incapacitating reversible health effects. Their presence in the air is more localized than are criteria pollutants, and they are usually found at highest levels close to their sources.

The U.S. Clean Air Act has been amended several times. A major set of amendments related to toxic air pollutants occurred in November of 1990. The passage of the 1990 amendments marked an overall change in the U.S. government's approach to air pollution control. These amendments placed renewed emphasis on controlling emissions of hazardous air pollutants (HAPs) and introduced initiatives to control acid rain and the depletion of stratospheric ozone.

The 1970 amendments to the Clean Air Act had regulated HAPs via National Emissions Standards for Hazardous Air Pollutants, or NESHAP. It required EPA to set emissions standards (limits on how much of the pollutants could be emitted into the air by a source) for hazardous air pollutants. EPA first had to identify which substances were to be classified as HAPs and then had to establish quantified exposure limits that would protect humans from any adverse health effects by these pollutants. EPA found it difficult, however, to establish these standards because of the uncertainty inherent in assessing health risks. As a result, only eight pollutants—asbestos, vinyl chloride, benzene, arsenic, beryllium, mercury, radon, and radionuclides other than radon—have had a health-based NESHAP set for them. There were many other hazardous pollutants that could potentially meet the definition of being health risks, however, so another means of approaching the problem was needed.

The 1990 Clean Air Act Amendments changed EPA's approach to regulating HAPs. Because the NESHAP program did not work as it was originally intended, the 1990 Clean Air Act amend-

ments introduced a new approach to dealing with the threats to public health from HAPs. This approach called for a two-phased regulatory scheme: a technology-based HAPs emission reduction plan to be followed by a second phase of further HAPs emission reduction to eliminate any remaining risk to public health. Phase I is to be implemented over the near term (approximately 10 years) for 189 specific HAPs. (Others can be added or deleted as more health-risk information becomes available.) If the resulting HAPs emissions still cause a public health threat, then those sources emitting such HAPs will be subjected to a second round of emission reduction requirements.

Rather than basing standards on health risks, EPA can now set standards based solely on the availability of control technology. In other words, if the hazardous pollutant can reasonably be controlled to a certain degree, then that is the degree to which it must be controlled. EPA must develop technology-based emissions standards for all of these pollutants. All pollutants that are either known or suspected to cause cancer and other serious, irreversible adverse health effects are included in the list. A majority of the listed compounds are volatile organic compounds (VOCs).

Hazardous (toxic) air pollutants can cause various health effects. Toxins are often classified by their effects into the following categories: mutagens, carcinogens, developmental toxins, neurotoxins, hepatotoxins, pulmonary toxins, agents that cause reproductive dysfunction, agents that are acutely toxic, and agents that are chronically toxic.

Mutagens are substances that cause mutations (alterations) in genetic material. Most cancers are believed to be caused by damage to a gene that regulates cell division. DDT, dioxin, ozone, lead salts, benzene, and vinyl chloride are common gaseous or airborne mutagens.

Carcinogens are chemicals that induce cancers, which are abnormal, uncontrolled growths of cells. A primary carcinogen is a substance that is carcinogenic in the form in which it occurs in the environment. A procarcinogen becomes carcinogenic only after it has been converted from some benign form. Most environmental carcinogens start out as procarcinogens. Cocarcinogens potentiate the carcinogenic effect of other chemicals. Asbestos, benzene, beryllium, chromium, radionuclides, and vinyl chloride are some human carcinogens.

Teratogens directly damage fetuses at doses that do not affect the mother. Lead, dioxin, organic mercury, alcohol, and cigarettes are known or suspected teratogens. Other developmental toxins affect the body during the early years of life, before all body systems have finished developing.

Neurotoxins affect any part of the nervous system, such as the brain, other nerve cell bodies, nerve fibers, myelin sheaths that cover nerve fibers, nerve-nerve junctions, and nerve-muscle junctions. Cyanide, lead, organophosphate insecticides (e.g., malathion, parathion), acrylamide, DDT, and some forms of mercury are neurotoxins.

Hepatotoxins affect the liver. They can cause jaundice, cell death, cirrhosis, and cancer. Some increase or decrease levels of metabolic enzymes in the liver and, consequently, affect the toxicity of other compounds by changing their metabolism. Carbon tetrachloride is an example of a hepatotoxin whose toxic effects are increased by the liver. Beryllium, chloroform, trichloroethylene, and vinyl chloride are other common hepatotoxins.

Pulmonary toxins affect the lungs. They can cause irritation and constriction of air passages, necrosis, edema, fibrosis, and cancer. They can cause anything from discomfort to death. While irritant effects are usually reversible, chronic exposure to an irritant can cause permanent damage. Asbestos, arsenic, toluene diisocyanate, and radiation are examples of pulmonary toxins.

Agents that cause reproductive dysfunction include radiation, benzo(a)pyrene, dimethylbenz(a)anthracene, and dibromochloropropane. These toxicants can decrease fertility, decrease the chance of the embryo or fetus to survive, or cause teratogenic effects.

Agents that are acutely or chronically toxic differ in the length of exposure required to cause adverse effects. Acutely toxic agents cause an adverse effect after only one short-term exposure. Formaldehyde is one such agent, and it causes eye, skin, and respiratory irritation. Chronically toxic agents require long-term or repeated exposures to cause an adverse effect. Asbestos is a classic chronic toxin. Chemicals may be both acutely and chronically toxic. For example, overexposure to a single dose of benzene may cause dizziness or unconsciousness, while long-term exposure may cause leukemia.

PROCEDURE

I. Setting the Stage

A. Give each student a copy of the handout, "Common Hazardous Air Pollutants and Symptoms of Acute Exposure."

B. Share with students the Background Information about HAPs and their effects.

II. Activity

A. Give students instructions for the HAPs Scavenger Hunt.

1. Give each student a copy of the handout, "HAPs Scavenger Hunt."

2. Instruct students to examine the labels, over the next two or three days, of household products and items and to record any of the common HAPs listed that they find. They can also go to grocery stores, hardware stores, furniture stores, nurseries, automotive stores, hobby shops, laboratories at school, or anywhere else they think they might find HAPs.

3. Have the students list safety precautions of each item found on their scavenger hunt.

4. Suggest that students speak with the school janitor to see what products he/she uses. Many schools (and hospitals) have a Materials Safety Data System Notebook that may be helpful.

CAUTION: REMIND STUDENTS TO BE VERY CAREFUL WHEN HANDLING ANY TYPE OF CHEMICAL.

B. Compile results

1. Using the information gathered by the students, compile a class list of the types of products containing the listed HAPs.

2. For each of the products, list an alternative that does not contain HAPs or lessens exposure to HAPs. For example, freshly dry-cleaned clothes can be hung outside for a few hours until the perchloroethylene has dissipated, you can use non-chlorine bleach, etc. Think about the use of products such as nail polish and lipstick. (Think about the effects of the alternatives, too.)

III. Follow-Up

A. Conduct research about the effects of commonly used HAPs.

1. Divide the class into three groups.

2. To the students in each group, assign a research project on one of these three commonly used HAPs:

- Ammonia
- Chlorine
- Perchloroethylene (dry-cleaning fluid)

3. Students should report on where these HAPs are commonly found, how they are commonly used, their health effects, information on safe/unsafe doses and exposure times, etc.

B. Present information

1. Each student should create an informational brochure based on the information found.

IV. Extension

A. Have each group develop a personal or family action plan to reduce their exposure to HAPs.

References

United States Environmental Protection Agency, Education and Outreach Group. *Course SI:422, Air Pollution Control Orientation Course.* Research Triangle Park, 1992.

United States Environmental Protection Agency, Education and Outreach Group. *Course SI:300, Introduction to Air Pollution Toxicology.* Research Triangle Park, 1993.

Common Hazardous Air Pollutants and Symptoms of Acute Exposure

Chemical	Acute Symptoms
Acrolein	Irritation of eyes & mucous membranes of respiratory tract
Aluminum	Cough, shortness of breath
Ammonia	Immediate upper and lower respiratory tract irritation and edema
Arsenic	Bronchitis
Asbestos	None, which makes it all the more insidious
Benzene & alkylbenzenes	CNS depression, unconsciousness, often fatal (occurs only at high concentrations)
Beryllium	Pulmonary edema, pneumonia
Cadmium	Cough, pneumonia
Carbon tetrachloride*	Liver damage
Chlorine	Cough, shortness of breath, tracheobronchitis, bronchopneumonia
Chloroform	Dizziness, gastrointestinal upset, unconsciousness (at high doses)
Chromium	Nasal irritation, bronchitis
DDT	Tingling of tongue, lips, face; dizziness; tremor
Formaldehyde	Irritation of eyes, nose, & upper respiratory tract
Hydrochloric acid	Pulmonary edema, irritation of eyes
Hydrogen fluoride	Respiratory irritation, hemorrhagic pulmonary edema
Manganese	Acute pneumonia (often fatal)
Mercury	Excitability, tremor, gingivitis
Methyl bromide	Pulmonary edema, headache, nausea, vomiting
Nickel	Pulmonary edema (2 days post-exposure)
Pentachlorophenol	Neurotoxicity
Perchloroethylene*	Pulmonary edema
Phosgene	Pulmonary edema
Radiation	Pulmonary fibrosis, radiation sickness
Selenium	"Garlic" breath, nausea, dizziness
Toluene*	Acute bronchitis, bronchospasm, pulmonary edema
Trichloroethylene*	Liver toxicity
Vinyl chloride	Portal hypertension
Xylene*	Pulmonary edema

* Acute symptoms also include central nervous system effects such as dizziness and headache.

HAPs Scavenger Hunt

Chemical	Product(s) in Which Chemical Was Found
Acrolein	
Aluminum	
Ammonia	
Arsenic	
Asbestos	
Benzene & alkylbenzenes	
Beryllium	
Cadmium	
Carbon tetrachloride*	
Chlorine	
Chloroform	
Chromium	
DDT	
Formaldehyde	
Hydrochloric acid	
Hydrogen fluoride	
Manganese	
Mercury	
Methyl bromide	
Nickel	
Pentachlorophenol	
Perchloroethylene*	
Phosgene	
Radiation	
Selenium	
Toluene*	
Trichloroethylene*	
Vinyl chloride	
Xylene*	

