Indoor Air Pollution Solutions

Background

Discuss with your students the concept of air pollution and its various forms. We have all seen air pollution—smoke that comes out of the exhaust pipe of buses, trucks, and cars. What about the air inside your home or school? Is this air "safe" to breathe? Is it clean?

Discuss the idea that while your indoor air may look and smell clean because you can't see any pollution, scientists have found that the air inside your house and school contains an invisible and often odorless form of gaseous chemicals emitted from many everyday furnishings and objects. In particular, poorly ventilated buildings trap these gases and are more prone to indoor air pollution, because the air cannot circulate and is not replenished with cleaner air.

Discuss indoor air pollution, including tobacco smoke, dust, paint thinner, cleaners, pesticides, radon gas, wood burning fireplaces, chemicals from personal care products, and so on. Explain that gases can be odorless and invisible and that high concentrations can be harmful.

The chemicals in the air are emitted from everyday objects that you would find and use around your home and in your school. Things that you would never expect to contribute to air pollution include: the furniture in your house or school, the paint on the walls, carpeting, the ink in printed materials such as books and newspapers, plastic and painted toys, and dry-cleaning solutions used to clean your clothes.

Explain to students that the chemicals used in or resulting from the manufacturing process of these products are emitted into the air and can cause your eyes, nose, and throat to feel irritated. These chemicals may cause headaches, make you feel drowsy, or develop more severe symptoms. In these cases, where the air inside buildings has made people feel sick, scientists have come up with the name "sick building syndrome" to describe the problem. The strength of the pollutant in the air, the amount of air in the room, how much air is being used up (breathed in), as well as the sensitivity of each individual plays a role in this process. Often, scientific equipment is used to measure the presence and amounts of substances in the air.

Share with students that there are some simple things that they can do to help clean the air. NASA researchers, led by Bill Wolverton, Ph.D., have found that common house plants can rid the air of a variety of pollutants. In particular, findings from his research are used to remove airborne pollutants from sealed environments like the space station.

Discuss photosynthesis, the process by which plants clean the air. It works like this: plants absorb carbon dioxide, which we exhale, and give off oxygen, which we breathe in. Plants absorb the pollutants/gasses through their leaves and roots and convert them to harmless substances. Scientists have found that in laboratory studies plants removed as much as 87% of the indoor air pollution within 24 hours!

Grade Levels:
Activity 1 - 5th grade
Activity 2 - 5th & 6th grades

Science SOLs:
5.4, 5.6, 6.9, 6.10

Materials:
- **Calculator**
- **Tape measure (if using classroom as the setting)**

Objectives:
1. **Students will understand air pollutants, including invisible and non-odorous sources of indoor air pollution.**
2. **Students will understand the link between breathing polluted indoor air and health.**
3. **Students will develop solutions to this pollution in a "real-life" setting.**

Vocabulary Words:
emission
microgram
sick building syndrome

Table 1: List of common pollutants, side effects, sources, and pollution-fighting plants.

Pollutant	Possible Side Effect	Source	Pollution Fighter
Benzene	skin and eye irritant, headaches, loss of appetite, drowsiness, tiredness, and other	inks, oils, paints, plastics, rubber, dye, detergents, gasoline, tobacco smoke, synthetic fibers	Dracaena marginata, English ivy, Janet Craig (fern), Warneckel, Peace lily
Formaldehyde	irritated eyes, nose, throat, headaches, contact dermatitis, and others	foam insulation, plywood, particle board, pressed wood products, plastic grocery bags, wax paper, facial tissue, paper towels, water repellants, adhesive binders in floor coverings, cigarette smoke, natural gas and kerosene, new synthetic carpets, new furniture made from pressed wood	Boston fern, Chrysanthemum, Gerber daisy, Dwarf date palm, Bamboo palm
Thrichloro-ethylene	potential for liver damage	used in dry cleaning and in printing inks, paints, varnish, and adhesives	Gerber daisy, Peace lily, Warneckel, Chrysanthemum, Dracaena marginata
Xylene		a solvent in paints and varnishes	Areca palm, Chrysalidocarpus, Lutescens, Dwarf date palm, Phoenix roebelenii, Bamboo palm, and others

Dr. Bill Wolverton, who currently maintains his own laboratory facility, has worked both at NASA and as a consultant to *The Plants for Clean Air Council*. Through his research he developed a formula that you can use to create a plan for clean air in your classroom or home:

> **Two or three plants per 10 square meters* (or 22.6 cubic meters with a standard ceiling). If you have a newly constructed house or lots of new furniture, you should fill each room with plants.**
>
> ***hundred square feet of space for a standard building**

Activity #1: 5th grade level

Read the following scenario to your students:

The school you attend is 10 years old. It is the fall and late last spring new carpeting was installed. In addition, during the past summer, all the halls in your school were repainted. Your classroom received a large workstation (3m x 2m) comprised primarily of pressed wood.

- Have students measure your classroom to determine its square footage.
- Determine the number of plants needed to keep the air clean.
- Determine the types of plants needed to clean the air based on materials contained in the room.

Activity #2 5th and 6th grades

Dr. Wolverton's research has found that different plants remove chemicals from the air at varying rates. In other words, the volume of "air exchange" that one plant can treat varies by the type of plant and chemical being treated for. In addition, the U.S. Environmental Protection Agency (EPA) has conducted research to determine the mean indoor air concentration of chemicals found in various buildings.

Table 2: Removal Rate Per Hour by Plant Type

Plant Type	Removal Rate Per Hour: Formaldehyde	Xylene
Boston Fern	1863 µg/hour	208 µg/hour
Janet Craig	1361 µg/hour	154 µg/hour
Rhododendron	617 µg/hour	168 µg/hour

µg=microgram (one-thousandth of a gram)

Table 3: Mean Indoor Air Concentration of Chemicals Found in Nursing Homes

Chemical	Mean Concentration
Formaldehyde	0.081 µg/liter
Xylene	0.005 µg/liter

Use the following as a case study to determine which and how many plants are needed to clean the air continuously:

u You have been brought in to consult with the managers of a local nursing home facility. Residents have complained recently of headaches and tired, scratchy, irritated eyes. The facility is 25 years old and has undergone recent renovation including new paint throughout and new carpeting in each resident's room. Each resident has also received new furnishings made of pressed wood board, including a bed and bedside table for their individual room. The room measurements are 3.05 meters long by 3.05 meters wide, with a 2.4-meter ceiling.

u The managers of this facility are asking for your help to reduce the number of complaints they are receiving from the residents and make them more comfortable in their surroundings.

1. Determine the origins of the chemicals that may be causing the residents' symptoms.

2. Determine which types of plants would be best used to clean the air of the specific chemicals involved.

3. Use the steps below to determine how many plants are needed to clean the air in each nursing home room:

u Calculate the air volume in the room by entering the dimensions of the room into the formula below:

length_____ x width_____ x height _____ = cubic meters
***Answer**: 22.64 cubic meters*

u Calculate the average concentration (amount) of each pollutant in the room by using the data in Table #3.

22.64 cubic meters x 1000 liters x _____mean (concentration) μg = _____ μg
***Answer**: 22,640 liters x .081 micrograms per liter (formaldehyde)=1834 μg*
22,640 x .005 micrograms per liter (xylene) = 113 μg

u Refer to Table #2 for the removal rates of plants to determine the number of each type of plant needed to clean the air.

_____μg pollutant divided by the removal rate/hour = number of plants needed to clean the air
***Answer**: 1834 divided by 1863 (Boston fern) = 1 Boston fern plant.*
You can use the same formula for other plants types as well.

Use the table below to collect your responses:

Chemical	Amount of Chemical (found in each room)	Plant Type	Number of Plants Required

Answers:

Chemical	Amount of Chemical	Plant Type	Number of Plants
Formaldehyde	1834 μg	Boston Fern	1
		Janet Craig	2
		Rhododendron	3
Xylene	113 μg	Boston Fern	1
		Janet Craig	1
		Rhododendron	1

Extension: Complete the above activity(ies) using the dimensions of your own classroom and any applicable environmental conditions.

Major Man-made Air Pollutants

Pollutant	Description	Sources	Effects
Carbon monoxide (CO)	colorless, odorless gas	t vehicles burning gasoline t indoor sources include kerosene- or wood-burning stoves	t headaches, reduced mental alertness, heart damage, death
Lead (Pb)	metallic element	t vehicles burning leaded gasoline t metal refineries	t brain and kidney damage t contaminated crops and livestock
Nitrogen oxides (NO_x)	several gaseous compounds made up of nitrogen and oxygen	t vehicles t power plants burning fossil fuels t coal-burning stoves	t lung damage t react in atmosphere to form acid rain t deteriorate buildings and statues t damage forests t form ozone and other pollutants (smog)
Ozone (O_3)	gaseous pollutant	t vehicle exhaust and certain other fumes t formed from other air pollutants in the presence of sunlight	t lung damage t eye irritation t respiratory tract problems t damages vegetation t smog
Particulate matter	very small particles of soot, dust, or other matter, including tiny droplets of liquids	t diesel engines t power plants t industries t windblown dust t wood stoves	t lung damage t eye irritation t damages crops t reduces visibility t discolors buildings and statues
Sulfur dioxide (SO_2)	gaseous compound made up of sulfur and oxygen	t coal-burning power plants and industries t coal-burning stoves t refineries	t eye irritation t lung damage t kills aquatic life t reacts in atmosphere to form acid rain t damages forests t deteriorates buildings and statues

OZONE "BUSTERS"

Virginians can help reduce ozone on summer days in a number of ways:

- Avoid unnecessary car trips. Use the telephone or fax machine whenever possible. If you must drive, combine errands.
- Carpool, vanpool, or use public transportation (buses, subways, trains) when possible.
- Drive the most fuel-efficient vehicle available.
- Keep your car engine properly tuned and tires properly inflated.
- Avoid excessive engine idling while driving. Idling for more than 30-40 seconds uses more gasoline than restarting the engine.
- Refuel vehicles after dusk or early in the morning.
- Limit lawn mowing and the use of other gasoline-powered equipment, including outboard motors.
- Limit or halt open burning.
- Turn off unnecessary lights and electric appliances. If possible, raise the thermostat setting by 2-4 degrees to use less air conditioning. The less energy used, the less must be generated by power plants.