

DESCRIPTION	Room to Breathe		CONTENTS
<u>Science Concepts</u>	<ul style="list-style-type: none"> ● Collect data, calculate, analyze and evaluate how air volume and concentration of pollutants is related to overall air quality. ● Students will be introduced to the concept of human exposure, draw parallels between indoor and ambient air, and look at the importance of preserving the quality of indoor air. 	<ul style="list-style-type: none"> ● Information for Teachers ● Student Activities ● Assessment ● Adaptations & Extensions 	
<u>Math Connections</u>	<ul style="list-style-type: none"> ● Gather and record data to calculate classroom air volumes and human ventilation volumes. 		
<u>Grade Levels</u>	<ul style="list-style-type: none"> ● Grades 9-12 		
<u>Instructional Strategy</u>	<ul style="list-style-type: none"> ● Guided laboratory 		
<u>Time Line</u>	<ul style="list-style-type: none"> ● Laboratory Activity: 1-2 hours with pre-lab and post-lab assignments 		
<u>Standards</u>	<ul style="list-style-type: none"> ● National Science Education Content Standards ● <u>9-12 Content Standard A:</u> Abilities necessary to do scientific inquiry Understandings about scientific inquiry ● <u>9-12 Content Standard C:</u> As a result of their activities in grades 9-12, all students should develop an understanding of: Matter, energy, and organization in living systems ● <u>9-12 Content Standard F:</u> As a result of their activities in grades 9-12, all students should develop an understanding of: Environmental quality Natural and human-induced hazards Science and technology in local, national, and global challenges ● <u>9-12 Content Standard G:</u> As a result of their activities in grades 9-12, all students should develop an understanding of: Science as a human endeavor 		

GENERAL LESSON OVERVIEW

1. Review background information.
2. Go over pre-lab questions with students, making sure they understand the possible dangers of breathing polluted air.
3. Set up the burning candle demonstration.
4. Pass out the student activity and start the burning candle demonstration.
5. Discuss the burning candle.
6. Demonstrate to students how to measure the classroom: L x W x H. Help students with measurements and calculations when necessary.
7. Explain to students how to calculate ventilation volume - # normal breaths in one minute.
8. After students complete lab and questions, discuss answers.

BACKGROUND**Indoor air Pollution**

Air in most indoor environments contains a variety of particles and gaseous contaminants. These contaminants are commonly referred to as indoor pollutants when they affect human health and performance. Indoor temperature and relative humidity can also affect health and performance directly, and can affect human performance indirectly by influencing the airborne level of molds and bacteria. These pollutants especially affect closed environments, such as air in space vehicles and space station habitats.

Most often, poor indoor air quality in a classroom results from the failure to follow practices that help create and maintain a healthy indoor environment. Common examples include failure to:

- control pollution sources such as art supplies and laboratory activities;
- control temperature and humidity;
- control moisture and clean up spills;
- ventilate each classroom adequately;
- adequately perform housekeeping and maintenance; and
- use integrated pest management to minimize the use of pesticides.

On the shuttle or International Space Station (ISS), all mission equipment is checked for is off-gassing. However, astronauts' personal equipment may emit polluting gases and each crew member may add new microbes to the flora found in the closed environment.

When buildings get sick

The term "sick building syndrome" (SBS) is used to describe situations in which building occupants experience acute health or comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified. The complaints may be localized in a particular room or zone, or may be widespread throughout the building. * Note - Complaints may result from other causes. However, studies show that symptoms may be caused or aggravated by indoor air quality problems.

- Indicators of SBS include:
 - Building occupants complain of symptoms associated with acute discomfort, e.g., headache; eye, nose, or throat irritation; dry cough; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odors.
 - The cause of the symptoms is not known.
 - Most people showing symptoms report relief soon after leaving the building.

Schools can get sick, too

Evidence continues to emerge showing that poor indoor air quality (IAQ) in schools can cause illness requiring absence from school, and can cause acute health symptoms that decrease performance while at school. In addition, recent data suggest that poor IAQ may directly reduce a person's ability to perform specific mental tasks requiring concentration, calculation, or memory.

How to reduce the hazards

Several strategies may be used to improve indoor air quality. A combustion furnace, if located indoors, should be efficient and atmospherically separated from the rest of the house. Solar heating and electric space heaters and kitchen ranges are better alternatives to kerosene and gas versions. Insulation of living spaces and metal conduits are recommended. Household cleaners, paints, and other products in the house should be sealed and stored properly to avoid leaking into the living area of a house. A ventilation-controlled system can provide fresh air every day.

Typical Sources of Indoor Air Pollutants			
Outside sources	Building equipment	Components/ Furnishings	Other Indoor sources
<p><u>Polluted outdoor air</u></p> <ul style="list-style-type: none"> - Pollen, dust, fungal spores - Industrial emissions - Vehicle emissions <p><u>Nearby sources</u></p> <ul style="list-style-type: none"> - Loading docks - Odors from dumpsters - Unsanitary debris or building exhausts near outdoor air intakes <p><u>Underground sources</u></p> <ul style="list-style-type: none"> - Radon - Pesticides - Leakage from underground storage 	<p><u>HAVC Equipment (Heating, Ventilation, and Air Conditioning)</u></p> <ul style="list-style-type: none"> - Microbiological growth in drip pans, ductwork, coils, and humidifiers - Improper venting of combustion products - Dust or debris in ductwork <p><u>Non-HVAC Equipment</u></p> <ul style="list-style-type: none"> - Emissions from office equipment (volatile organic compounds, ozone) - Emissions from shops, labs, cleaning processes 	<p><u>Components</u></p> <ul style="list-style-type: none"> - Microbiological growth on soiled or water-damaged materials - Dry traps that allow the passage of sewer gas - Materials containing volatile organic compounds, inorganic compounds, or damaged asbestos - Materials that produce particles (dust) <p><u>Furnishings</u></p> <ul style="list-style-type: none"> - Emissions from new furnishings and flooring - Microbial growth on or in soiled or water-damaged furnishings 	<ul style="list-style-type: none"> - Science laboratories - Vocational arts areas - Copy/print areas - Food prep areas - Smoking lounges - Cleaning materials - Emissions from trash - Pesticides - Odors and volatile organic compounds from paint, chalk, adhesives - Occupants with communicable diseases - Dry-erase markers and similar pens - Insects and other pests - Personal care products

Room to Breathe

Student Activities

INTRODUCTION

Most people are aware that outdoor pollution can damage their health but may not know that the quality of the air indoors can be very poor too. Studies of human exposure to pollutants indicate that indoor levels of many pollutants may be two to five times higher, and occasionally more than 100 times higher than outdoor levels. Comparative risk studies performed by the EPA have consistently ranked indoor air pollution among the top five environmental risks to public health. Carpeting, manufactured wood products, and combustion appliances (gas and oil cooking stoves and furnaces, for example) are the three most important sources of hundreds of indoor air pollutants. Typical examples are methyl methacrylate, aliphatic hydrocarbons, ketones, formaldehyde, xylene, lead, bacteria, mold, dust mites, and known carcinogens like benzene, trichloroethylene, vinyl chloride, and tobacco smoke.

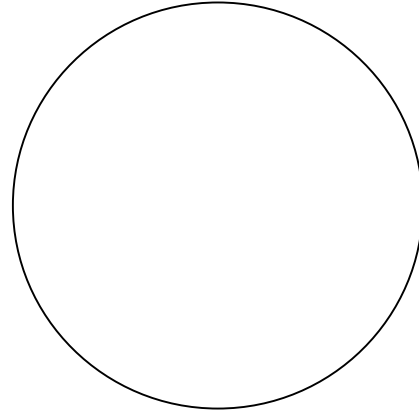
Some three hundred volatile organic compounds are known, and many of them are common in houses. Some houses are filled with synthetic materials that can release a wide range of hazardous chemicals into the air over time. In addition, many common household products, used without proper ventilation, and gases like radon, pose a serious health threat to people who spend over 90 percent of their time indoors. To make matters worse, while insulating our homes is important for energy conservation, it can decrease air exchange and increases pollutant concentrations indoors. The air in tightly sealed homes and buildings can constitute a health hazard. Air pollutants enter the body primarily through the lungs, which have a total surface area about 25 times greater than that of the body's skin surface. This large surface area makes the lungs an major organ for entry of gasses.

Concentrations of chemicals of air are measured in parts per million. Parts per million (ppm) is a way to measure very small concentrations. One part per million means that there is one molecule of chemical per one million molecules of air.

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PRE-LAB QUESTIONS

1. Where do you spend most of your time during the day? Estimate the percentage of time you spend at home, at school, in the car, etc. Fill and label the pie chart with this information.



2. Do you know any pollutants in your home that could make you sick? _____

3. How would you know whether there were pollutants in the air at home or school? Can all of these pollutants be seen or smelled? _____

4. What air pollutants might be present in the International Space Station? _____

INVESTIGATION QUESTION

What is the relationship between air quality and the volume of air in a living space?

PREDICTION: What do you think is a reasonable answer to the investigation question?

MATERIALS

1. measuring tape or yard stick (must measure in feet)
2. blank paper
3. calculator

PROCEDURE

1. As the instructor burns a candle in the front of the room, answer the following questions:
 - a. What pollutants (visble and invisible) are produced? _____
 - b. Do these pollutants smell bad? _____
 - c. If you can't smell a pollutant is it safe to breathe the air? _____

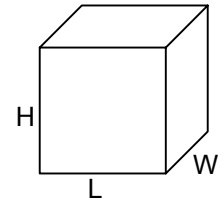
2. Measure indoor air volumes

- a. Follow your instructor’s directions for collecting the measurements of the room. Put the room measurements in their appropriate places on the lines below and calculate the volume of air in the room. Remember to include units in your measurement.

Length _____ x Width _____ x Height _____ = _____

- b. If you measured length, width, and height in feet; then convert the room’s volume from cubic feet to liters:

_____ ft³ x 28.317 = _____ L



3. Calculate human ventilation rates

- a. Use the following formula to calculate the ventilation rate, volume per minute (total minute volume). Assume the tidal volume is 0.5L of air for each breath. Follow your instructor’s directions for measuring the number of breaths you take per minute (ventilation rate). Put your measurement and the 0.5 L tidal volume in their appropriate places on the lines below and calculate total volume per minute:

Tidal volume 0.5 (L) x Ventilation rate _____ (breaths/min) = _____ L/min

- b. Volume of air inhaled during one hour:

_____ (L/min) x 60 = _____ L/hour

- c. Calculate how much air is inhaled by all those in the room in one hour:

_____ (L/hour per person) x _____ people in the room = _____ ventilation rate (L/hour)

4. Comparing Volumes and Rates

Total Volume of air in the room (L)	
Ventilation rate – single person (L/hr)	
Ventilation rate – entire class (L/hr)	

- a. How much air do you and your classmates need to breathe comfortably? Is there enough air in the room for you and all your classmates too?

- b. Knowing how much air people are breathing vs. how much air is in the classroom, how might it effect your health if mold spores or chemical particles are present?

- c. What is the source of fresh air you need in the classroom? Is it really fresh?

If the room were sealed (no outside air coming into the room), how long would you and your classmates survive at your current breathing rates?

- d. How could being confined to a small space, such as a submarine or the space shuttle, for a long period of time effect your health?

ASSESSMENT – GROUP QUIZ

1. Name four sources of indoor pollutants.

a. _____

b. _____

c. _____

d. _____

2. What pollutants might be in our classroom right now? How could we test for pollutants?

3. If your ventilation rate is 600 L/Hr, how long would it take for you inhale all the air in a 1,800 L space if you don't inhale the same air more than once? Show your work.

4. If the ventilation rate for your entire class is 18,000 L/Hr, how long would it take for your class inhale all the fresh air in a 18,000 L space? Show your work.

5. What might happen to pollutant particles in our room?

6. Describe some ways that astronauts could get fresh air on the International Space Station.

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Adaptations/Extensions

ADAPTATIONS

- Have students sketch a diagram of the classroom before measuring it. If needed, give dimensions to students unable to take measurements.

EXTENSIONS

- Compare the ventilation rates over eight hours with the volume of air in the room. Facilitate a student discussion of how increased physical activity would affect their exposure to air pollution.
- Ask students: If you had a known pollutant gas in your classroom, would you rather it be at a concentration of one parts-per-thousand, one parts-per-million, or one parts-per-billion? Make them explain the terms and justify their answers.
- Obtain the EPA's "IAQ Tools for Schools" Kit (free of charge from www.epa.gov/iaq/schools) and have students test the indoor air quality of the entire school.
- Have students research IAQ issues that professionals in building and interior design encounter when working in and/or building interior spaces.
 - Why is it important that these professionals are careful of what materials go into a space?
 - What is offgassing and why must it be taken into consideration?
- Have students brainstorm what kind of systems it would take to provide astronaut and submarine crew members with a continually high IAQ in a small space. Students may obtain information from NASA about materials research done for the space shuttle, the space station, the Mir, and Navy submarines. How do the choices of materials by these designers compare with choices of materials by professionals in building and interior design? What issues do these people have in common?