ACTIVITY 5

BREATHING ROOM

This activity lets students calculate the volume of air in the classroom and illustrates the importance of preserving the quality of indoor air. It also introduces concepts of human exposure, and draws a parallel between indoor air and ambient air. This activity is related to the warm-ups called "Read My Data" and "Where's That Odor" and the activity called "The Radon Game."

CRITICAL OBJECTIVES

- Define some visible or invisible and odorous and non-odorous indoor air pollutants
- Describe the link between illness and breathing polluted air
- Explain how the amount of air in a given space is related to the size of the space
- Calculate the amount of air in the classroom and how much air people breathe per minute and in one hour

SKILLS

- Observing
- Collecting data
- Organizing data
- Computing
- Drawing conclusions

GUEST PRESENTERS

Guest presenters could include air quality engineers, architects, EPA environmental protection specialists, or heating and ventilation technicians.

BACKGROUND

Most people are aware that outdoor air 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 air pollutants indicate that indoor levels of many pollutants may be two to five times, and occasionally more than 100 times, higher than outdoor levels. Comparative risk studies performed by 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

RELATED WARM-UPS
B, F

REFER TO READING MATERIALS
"Indoor Air Quality"
"Health Effects"

TARGET GRADE LEVEL
9th - 12th

DURATION
40 minutes

VOCABULARY
Odor detection threshold
Odor recognition threshold
Tidal volume
Total minute volume
Ventilation rate

MATERIALS
Metric conversions
Ventilation volumes in human lungs
Tape measure for teacher/presenter
Large wall clock with second hand
Adhesive tape
Paper
Marker

WORKSHEETS INCLUDED
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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—most of whom 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 excellent filter. (See the reading materials on "Indoor Air Quality" and "Health Effects.")

WHAT TO DO

1. Ask students where they spend most of their time. Have students estimate the percentage of time they spend at home, at school, in the car, and so on. Have them draw a pie chart on a sheet of paper, illustrating this information. This process should reveal that most of their time is spent indoors. Ask students to estimate how much of a 24-hour day they spend indoors in winter and summer.

2. Discuss the importance of ensuring that the places they spend most of their time are free of pollutants that could make them sick. Ask students if they know of any pollutants in their homes that could make them sick. If necessary, prompt students by suggesting, for example, tobacco smoke, dust, particulates, paint thinners, grease cleaners, pesticides, radon gas seeping into the house through cracks in the basement walls or floor, dry-cleaned clothing and drapes, chemically formulated personal care products, faulty heating units, cooking appliances, wood burning fireplaces and stoves, some synthetic building materials, wall coverings, carpet, and furniture.

3. Ask students how they would know whether there are pollutants in the air at home or school? Can such pollutants be seen or smelled? Discuss the fact that only some indoor air pollutants like tobacco smoke and insecticides are visible or smelly enough to detect easily at certain concentrations.

4. Explain that many pollutants, such as radon, have no odor and are invisible.

5. Burn a candle or incense to produce visible and invisible (carbon dioxide) pollutants. Ask the students if all pollutants smell bad. Discuss odor detection threshold (minimum odorant concentration required to perceive the existence of the pollutant) and odor recognition threshold (minimum odorant concentration required to identify the pollutant). For example, ammonia has a detection threshold of 17 parts per million (ppm) and a recognition threshold of 37 ppm. Ask the students if they think that if they can't smell a pollutant it is safe to breathe.

6. Explain that concentrations in the air are measured as parts per million (ppm), not as percentages (as in the pie chart they drew).

7. Explain that pollutants in the air can make people sick depending in large part on how much air is in the space people occupy, how much pollutant is in that space, how much air people breathe, and the sensitivity of the individual.

8. Explain that it is often necessary to rely on specialized scientific equipment to measure the presence and amounts of such substances in the air.

9. Introduce the activity. Hand out the student worksheet. Go over with students the formulas on the worksheet for calculating cubic feet and to convert cubic feet to liters for easy comparison to human lung volumes. Tape measurements to the walls to show the height of the room. Tape measurements to the floor showing the length and width. (If you prefer, do this before class begins). Point out the location of the measurements, and notify the students that they have three minutes to gather and record the measurements on their worksheets. (You also could challenge the students to make these measurements without your assistance.)

10. Ask the students to do the calculations on their worksheets using the room measurements they have gathered.

11. Go over with students the formula on the worksheet for calculating human ventilation volumes. Ask the students to measure their own ventilation rates per minute and to compare their own rates with the average adult rate (14 breaths/minute) at rest. Using the formula and assumptions (0.5 L tidal volume) provided on the worksheet, ask the students to calculate total minute volume and the ventilation volumes over one hour.

12. Compare the calculated ventilation volumes in liters with the amount of air in the room and discuss the implications to health if air pollutants are present. Have students consider the following questions:

    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?
    Where is the fresh air you need in the classroom coming from? 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?

SUGGESTED EXTENSIONS (OPTIONAL)

- Compare ventilation volumes 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.

SUGGESTED READING

Becker, Brenda L. "Is Your Home Hazardous to Your Health." *Woman's Day*, 56 (21 September 1993) p. 36.

"Can a Building Really Make You Sick?" *University of California, Berkeley Wellness Letter*, 7 (July 1991) p. 1.

Delaney, Lisa. "The Air Doctors' Report: How to Protect Yourself from Dangers Blowing Through Your House." *Prevention*, 43 (August 1991) p. 44.

Greenfield, Ellen J. *House Dangerous: Indoor Pollution in Your Home and Office—And What You Can Do About It*. New York, NY: Random/Vintage (1987).

"How to Improve Indoor Air." *University of California, Berkeley Wellness Letter*, 8 (February 1992) p. 6.

"Indoor Air Pollution." *Mayo Clinic Health Letter*, 11 (November 1993) p. 4.

Lecard, Marc. "Better Homes in Gardens." *Sierra*, 78 (January 1993) p. 20.

Rifkin, Janey M. "When Breathing is Hazardous to Your Health." *Let's Live*, 59 (August 1991) p. 62.

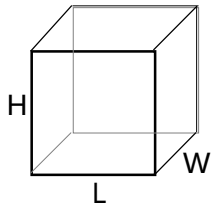
Safran, Claire. "Schools That Make Kids Sick." *Good Housekeeping*, 214 (March 1992) p. 176.

Turiel, Isaac. *Indoor Air Quality and Human Health*. Stanford, CA: Stanford University Press (1985).

STUDENT WORKSHEET 1
INDOOR AIR MEASUREMENT

Measure Indoor Air Volumes

1. Follow your instructor's directions for collecting the measurements of the room.



2. Put the room measurements in their appropriate places on the lines below and calculate the volume of air in the room in cubic feet:

Length_____ (ft) x Width_____ (ft) x Height_____ (ft) = _____ ft^3

3. To convert cubic feet to liters (L), multiply by 28.317.

Calculate Human Ventilation Volumes

1. Use the following formula to calculate the ventilation volume per minute (total minute volume). Assume the tidal volume is 0.5 L 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 minute volume:

Tidal volume__.5__ (L) x Ventilation rate_____ (breaths/min) = _____ L/min

2. Multiply the total minute volume by 60 minutes to obtain the volume of air breathed during one hour.

Compare Volumes

1. Compare the volume of air you breathe in one hour with the total volume of air in the room.

2. Calculate how much air is breathed by all those in the room. Multiply the total hourly volume by the number of people in the room, and compare this value to the total volume of air in the room

TAKE NOTE!
This exercise does not consider the exchange of fresh air in an enclosure depending on the ventilation capacity. Be sure to discuss this with your students so that they do not get the impression that their classroom is hazardous to their health.