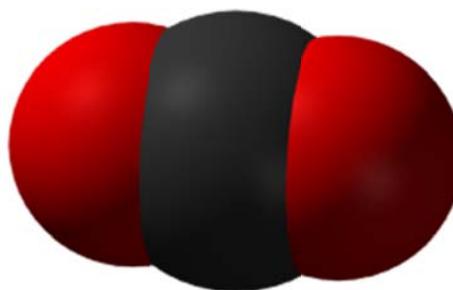


Student Tools for Measuring Air Pollution

This document provides a number of tools that can be used by students to measure various types of air pollution. There are a number of pollutants that can harm the people and the environment including; carbon monoxide, carbon dioxide, oxides of nitrogen, particulate matter, and volatile organic compounds. This site provides tools to measure several of these compounds that are safe for students to measure including; carbon dioxide, oxides of nitrogen, and particulate matter.

Carbon Dioxide (CO₂)

Carbon dioxide (CO₂) is emitted by industrial processes and vehicles and contributes to global warming. CO₂ is also produced when animals exhale, and by natural processes such as volcanic eruptions. While plants absorb CO₂ as part of photosynthesis, excessive CO₂ can increase the acidity of water and kill plants.



Carbon Dioxide is made up of one carbon atom and two oxygen atoms (*pictured right*).

Tools

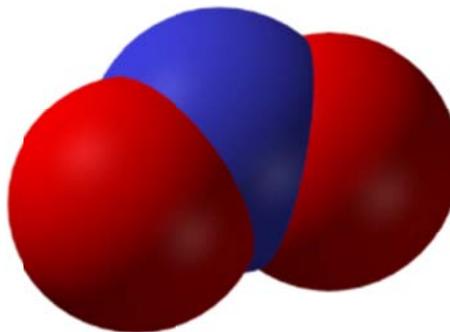
- Bromthymol blue - Student can use bromthymol blue to measure the concentration of CO₂ in liquid samples from various sources. Bromthymol blue is a pH indicator for weak acids and bases. Presence of CO₂ in water can increase the amount of carbonic acid, thus increasing acidity. Bromthymol blue is available from scientific supply stores (see the Resources section). Alternatively, litmus paper is easily available in scientific supply stores and can also be used to test for acidity.

- Plant growth - Students can measure the effects of increased CO₂ in the atmosphere by examining the effects of acid on plants. By using lemon juice or similar weak acid students can test the effects of pH on seed germination, or measure the damage done to grown plants when exposed to acids. If available, carbonic acid would provide the same results as acid rain produced by NO_x compounds. Strong acids are restricted and can only be used in the classroom with adult supervision and appropriate safety equipment.

Oxides of Nitrogen (NO_x)

Oxides of nitrogen, or nitrogen oxides (NO_x), are products of combustion. These chemicals are responsible for much of the brown "smog" seen in the Kern region. NO_x compounds are also precursors of ozone, which can effect human health and plant growth. Additionally, NO_x compounds combine with moisture in the atmosphere to form acid rain. Increases in NO_x compounds leads to increased levels of ozone, which can be responsible for irritating the lungs of people who suffer from asthma, bronchitis or emphysema.

A common NO_x compound is Nitrogen Dioxide, composed of two oxygen atoms and one nitrogen atom (*pictured right*).



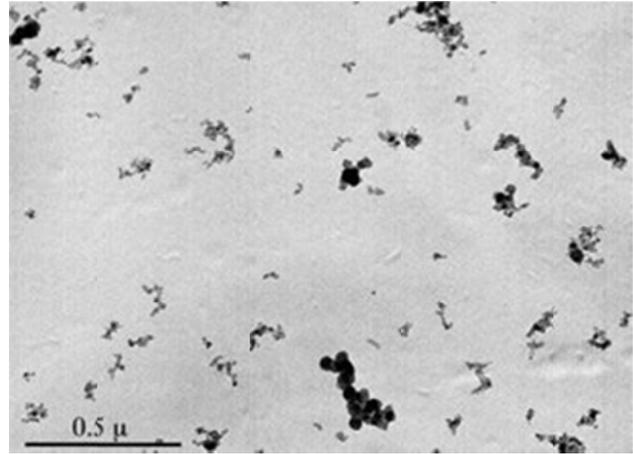
Tools

- Acid Rain - Students can measure the effects of NO_x as a factor in acid rain by experimenting on the effects of acid on plants. By using lemon juice or similar weak acid students can test the effects of pH on seed germination, or measure the damage done to grown plants when exposed to acids. If available, nitric acid would provide the same results as acid rain produced by NO_x compounds. Strong acids are restricted and can only be used in the classroom with adult supervision and appropriate safety equipment.

Particulate Matter (PM)

Particulates are small particles that can create health problems. Exposure to particulate matter can cause many breathing problems such as bronchitis or asthma. Particulate matter is categorized by size; PM 10 is particulate matter 10 microns or smaller, PM 2.5 is particulate matter 2.5 microns or smaller. A micron is one millionth of a meter, a strand of human hair is 100 microns wide. The following tools will allow students to gather particulate matter samples, but only PM 10 particles will be visible using standard microscopes.

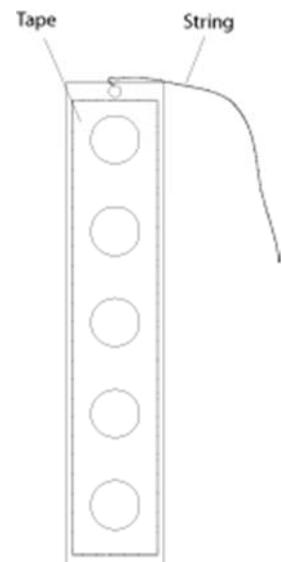
A common type of particulate matter is diesel particulate matter, produced by diesel vehicle emissions (*pictured right*).



Tools

- Student can use microscope slides coated with petroleum jelly to gather samples of particulate matter. These samples can be examined using a microscope.

- Students can use clear tape and cardboard to make an air strip to collect particulate matter samples. Take a strip of cardboard 2"x10" and cut five 1" holes in it. Cover the holes with tape with the sticky side exposed on one side. (*see diagram at right*) These tools can be placed or hung in various locations to collect samples. These samples can be examined using a microscope.



- Student can also use filter paper to gather samples of particulate matter. These samples can be examined with the naked eye.

- Students can use white gym socks to gather samples of particulate matter and soot from vehicle exhaust pipes. This should only be done with adult supervision. These samples can be examined with the naked eye.

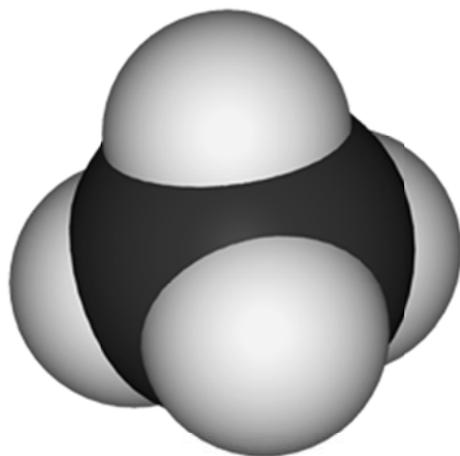
Volatile Organic Compounds (VOC)

Volatile organic compounds (sometimes called reactive organic gasses or reactive hydrocarbons) are the product of combustion or are released by some chemicals, like paints. These compounds are responsible, along with NO_x, for creating California's infamous smog. Not only can VOCs cause respiratory illness, they can even lead to cancer and other life threatening illnesses.

The most common VOC in air pollution is methane gas, composed of one carbon atom and four hydrogen atoms (*pictured above right*).

Non-methane volatile organic compounds (NMVOC) include benzene, formaldehyde, cyclohexane, 1,1,1-trichloroethane, acetone and ethanol. Ethanol is composed of two carbon atoms, one oxygen atom, and six hydrogen atoms. (*pictured below right*)

Because VOCs are dangerous chemicals no experiments using VOCs should be done without adult supervision. Most VOCs used in science fair projects are restricted to classroom use.



Tools

- Students can use plant or microbe bioremediation techniques to demonstrate the effectiveness of bioremediation at removing VOC from water or soil samples. Kits to measure VOC levels are available in science supply catalogs. Water samples can be obtained from local rivers and streams, and soil samples can be obtained at school, home, or at the park.