

**Ozone, Particulate Matter, and Carbon Monoxide – Oh My!**

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**Abstract**

During this lesson students will observe the formation of ozone and the effects of ozone, particulate matter (PM 2.5 and PM 10), and carbon monoxide on the lungs. The purpose of this lesson is to give students the opportunity to explore the creation of ozone, and the effects of different pollutants on the lungs

**Objectives**

Students will be able to:

- Describe the formation of ozone.
- Describe the affects of ozone, particulate matter and carbon monoxide on the lungs.

**National Science Education Standards**

Content Standard D - STRUCTURE OF THE EARTH SYSTEM

The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations. Clouds, formed by the condensation of water vapor, affect weather and climate.

Content Standard D - EARTH IN THE SOLAR SYSTEM

The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface. This is due to the tilt of the earth's rotation on its axis and the length of the day.

**Arizona Science Education Standards**

Strand 6 - EARTH SCIENCE

Concept 1 – Structure of the Earth

PO 1. Describe the properties and the composition of the layers of the atmosphere.

PO 5. Describe ways scientists explore the Earth's atmosphere

**Teacher Background**

Ozone is the name for 3 oxygen atoms linked together. When in the upper atmosphere, ozone protects us from harmful ultraviolet solar radiation. However, when it forms in the lower atmosphere, it is corrosive and a health hazard to humans. Ozone is formed when the combination of Volatile Organic Compounds (VOCs), Nitric Oxide (NO) and Nitrogen Oxides (NOx) react in the presence of sunlight. Therefore, ozone levels are lower in the morning and at night, when it is not as sunny, and higher in the afternoon, in the presence of sunlight. In some studies, ozone has been shown to reduce lung function. Exposure to high levels of ozone severely aggravates respiratory illnesses like asthma. Studies show that children living in communities with high levels of ozone miss more days of school than children in less polluted communities.

Particulate Matter (PM) is solid particles and liquid droplets suspended in the air. PM comes from a variety of sources and breathing in the smaller particles can be dangerous. PM 10 describes particles that are less than 10 microns in diameter. They tend to come from dust from roads, industry, agriculture, wood fires, construction and demolition, and fly ash from fossil fuel combustion. The particles can be suspended in the air anywhere from a few minutes to hours and can travel up to 10 kilometers before settling. PM 2.5 describes particles that are less than 2.5 microns in diameter. Sources of PM 2.5 include fossil fuel combustion (such as industrial and vehicle emissions), agricultural burning, and the smelting and processing of metals. These tiny particles can be suspended in the air from days to weeks and can travel from hundreds to thousands of kilometers. Some particles are even smaller. Scientists worry about the small particles because they can be inhaled and the particles (as well as the chemicals attached to them) can get into the lungs, into the bloodstream, and to other parts of the body (including the brain and heart).

Carbon Monoxide (CO) is another air pollutant of concern. The primary source of CO is motor vehicles in urban areas, hot water heaters and home heating systems fueled by natural gas. CO can bond with the hemoglobin in the blood. This impairs the blood's ability to carry oxygen to rest of the body and strains tissues that require high levels of oxygen (such as the heart and brain) and can decrease the ability of other cells to utilize oxygen. In the outdoor air, high levels of carbon monoxide are an indicator that there

## Asthma and Allergies Health Observance Package

is significant traffic. Traffic exhaust is linked to an increase in incidence and prevalence of asthma and in making asthma symptoms worse.

### Related and Resource Websites

<http://coep.pharmacy.arizona.edu/air/index.html>

<http://www.airinfonow.org/html/health.html>

<b>Time</b>	1 class period (45 minutes)
<b>Preparation Time</b>	5 minutes
<b>Materials</b>	Computers
<b>Teacher Preparation</b>	Secure access to computer lab The day prior, remind students to meet you in the lab.\

### Activity

1. Arrange to have students meet you in the lab to allow for a full period using the computers.
2. Tell students, “Yesterday we talked about asthma and some of the contributing factors. What were some of those factors [pause for responses after each question]? Ozone was one. Do you think it only affects people with asthma? What about other forms of pollution that aggravate asthma? Do they only affect asthmatics?”
3. Tell students, “Today we will look at two simulations. The first shows how ozone is formed. The second shows you what happens to your lungs as four different pollutants -- ozone, particulate matter of two sizes, and carbon monoxide -- are inhaled. We will look at the ozone simulation first, then look at Lung Attack. As we are observing, be sure to collect the following data: What pollutant are you observing? Where does it come from? How does it affect your lungs/body?” (Depending upon the abilities of your students, you may want to ask for examples of appropriate data tables. A sample is included below.)

<b><u>Pollutant</u></b>	<b><u>Source</u></b>	<b><u>Health Effects</u></b>
O <sub>3</sub> (Ozone)		
PM 10 (Particulate Matter 10 microns)		
PM 2.5 (Particulate Matter 2.5 microns)		
CO (Carbon Monoxide)		

4. Go to the Air Info Now page at <http://coep.pharmacy.arizona.edu/air/index.html> . Click on “Activities” and then open the link to **A Recipe for Ozone**. Have students observe how the combination of VOCs and NO (nitric oxide) and NO<sub>x</sub> (nitrogen oxides) react in the presence of sunlight to make ozone. Discuss what students saw and clarify any confusion. Remind students to record data collected from this simulation.
5. Now open the link on the same page titled **Lung Attack**. Have students run the simulations on their own, reminding them to record data collected.
6. When students have finished, have them record what they learned and why it is important to their health as a conclusion in the science notebooks.

### Embedded Assessment

Move among the students while they are doing the simulations. Observe their abilities to follow instructions, manipulate the simulations and record notes about sources and health effects in their notebooks. Remind those who are not recording notes to do so.