# 07 Atmospheric Pollution

Content Area: **Science**
Course(s): **AP Environment**
Time Period: **Semester 2**
Length: **2 weeks**
Status: **Published**

## Standards

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|---|---|
| CCC.2 | Cause and effect: Mechanism and explanation. |
| CCC.2.1 | students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects. |
| CCC.4 | Systems and system models. |
| SEP.2 | Developing and Using Models |
| CCC.4.1 | students can investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They can use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They can also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They can also design systems to do specific tasks. |
| CCC.7 | Stability and change. |
| SEP.3 | Planning and Carrying Out Investigations |
| CCC.7.1 | students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability. |
| SEP.4 | Analyzing and Interpreting Data |
| SEP.6 | Constructing Explanations and Designing Solutions |
| SCI.HS-ESS3-3 | Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. |
| SCI.HS-ESS3-4 | Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. |
| SCI.HS-ESS2-6 | Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. |
| SCI.HS-ESS3-1 | Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. |

## Essential Questions

How do human actions and resource usage cause negative impacts on the natural systems of Earth and create risks to sustainable human civilization?

## Enduring Understandings

Human activities have physical, chemical, and biological consequences for the atmosphere.

## Knowledge and Skills

**Unit 7 Atmospheric Pollution**

### Topic 7.1 Introduction to Air Pollution

**Knowledge**

- Coal combustion releases air pollutants including carbon dioxide, sulfur dioxide, toxic metals, and particulates.
- The combustion of fossil fuels releases nitrogen oxides into the atmosphere. They lead to the production of ozone, formation of photochemical smog, and convert to nitric acid in the atmosphere, causing acid rain. Other pollutants produced by fossil fuel combustion include carbon monoxide, hydrocarbons, and particulate matter.
- Air quality can be affected through the release of sulfur dioxide during the burning of fossil fuels, mainly diesel fuels.
- Through the Clean Air Act, the Environmental Protection Agency (EPA) regulated the use of lead, particularly in fuels, which dramatically decreased the amount of lead in the atmosphere.
- Air pollutants can be primary or secondary pollutants.

**Skills**

- Explain modifications to an experimental procedure that will alter results.

### Topic 7.2 Photochemical Smog

**Knowledge**

- Photochemical smog is formed when nitrogen oxides and volatile organic hydrocarbons react with heat and sunlight to produce a variety of pollutants.
- Many environmental factors affect the formation of photochemical smog.
- Nitrogen oxide is produced early in the day. Ozone concentrations peak in the afternoon and are higher in the summer because ozone is produced by chemical reactions between oxygen and sunlight.
- Volatile Organic Compounds (VOCs), such as formaldehyde and gasoline, evaporate or sublimate at room temperature. Trees are a natural source of VOCs.
- Photochemical smog often forms in urban areas because of the large number of motor vehicles there.

- Photochemical smog can be reduced through the reduction of nitrogen oxide and VOCs.
- Photochemical smog can harm human health in several ways, including causing respiratory problems and eye irritation.

**Skills**

- Describe relationships among variables in data represented.

**Topic 7.3 Thermal Inversion**

**Knowledge**

- During a thermal inversion, the normal temperature gradient in the atmosphere is altered as the air temperature at the Earth's surface is cooler than the air at higher altitudes.
- Thermal inversion traps pollution close to the ground, especially smog and particulates.

**Skills**

Explain how environmental concepts and processes represented visually relate to broader environmental issues.

**Topic 7.4 Atmospheric CO2 and Particulates**

**Knowledge**

- CO2 appears naturally in the atmosphere from sources such as respiration, decomposition, and volcanic eruptions.
- There are a variety of natural sources of particulate matter.

**Skills**

- Describe an aspect of a research method, design, and/or measure used.

**Topic 7.5 Indoor Air Pollutants**

**Knowledge**

- Carbon monoxide is an indoor air pollutant that is classified as an asphyxiant.
- Indoor air pollutants that are classified as particulates include asbestos, dust, and smoke.
- Indoor air pollutants can come from natural sources, human-made sources, and combustion.
- Common natural source indoor air pollutants include radon, mold, and dust.
- Common human-made indoor air pollutants include insulation, Volatile Organic Compounds (VOCs) from furniture, paneling and carpets; formaldehyde from building materials, furniture, upholstery, and carpeting; and lead from paints.
- Common combustion air pollutants include carbon monoxide, nitrogen oxides, sulfur dioxide,

particulates, and tobacco smoke.
- Radon-222 is a naturally occurring radioactive gas that is produced by the decay of uranium found in some rocks and soils.
- Radon gas can infiltrate homes as it moves up through the soil and enters homes via the basement or cracks in the walls or foundation. It is also dissolved in groundwater that enters homes through a well.
- Exposure to radon gas can lead to radon induced lung cancer, which is the second leading cause of lung cancer in America.

**Skills**

- Explain patterns and trends in data to draw conclusions.

## Topic 7.6 Reduction of Air Pollutants

**Knowledge**

- Methods to reduce air pollutants include regulatory practices, conservation practices, and alternative fuels.
- A vapor recovery nozzle is an air pollution control device on a gasoline pump that prevents fumes from escaping into the atmosphere when fueling a motor vehicle.
- A catalytic converter is an air pollution control device for internal combustion engines that converts pollutants (CO, NOx, and hydrocarbons) in exhaust into less harmful molecules ($CO_2$, $N_2$, $O_2$, and $H_2O$).
- Wet and dry scrubbers are air pollution control devices that remove particulates and/or gases from industrial exhaust streams.
- Methods to reduce air pollution from coal burning power plants include scrubbers and electrostatic precipitators.

**Skills**

- Use data and evidence to support a potential solution.

## Topic 7.7 Acid Rain

**Knowledge**

- Acid rain and deposition is due to nitrogen oxides and sulfur oxides from anthropogenic and natural sources in the atmosphere.
- Nitric oxides that cause acid deposition come from motor vehicles and coal-burning power plants. Sulfur dioxides that cause acid deposition come from coal-burning power plants.
- Acid deposition mainly affects communities that are downwind from coal-burning power plants.
- Acid rain and deposition can lead to the acidification of soils and bodies of water and corrosion of human-made structures.

- Regional differences in soils and bedrock affect the impact that acid deposition has on the region—such as limestone bedrock's ability to neutralize the effect of acid rain on lakes and ponds.

**Skills**

- Identify a research method, design, and/or measure used.

**Topic 7.8 Noise Pollution**

**Knowledge**

- Noise pollution is sound at levels high enough to cause physiological stress and hearing loss.
- Sources of noise pollution in urban areas include transportation, construction, and domestic and industrial activity.
- Some effects of noise pollution on animals in ecological systems include stress, the masking of sounds used to communicate or hunt, damaged hearing, and causing changes to migratory routes.

**Skills**

- Describe the author's reasoning (use of evidence to support a claim).

Make connections to other units by considering:

Human activities, including the use of resources, have physical, chemical and biological consequences for ecosystems.

Key vocabulary you need to know

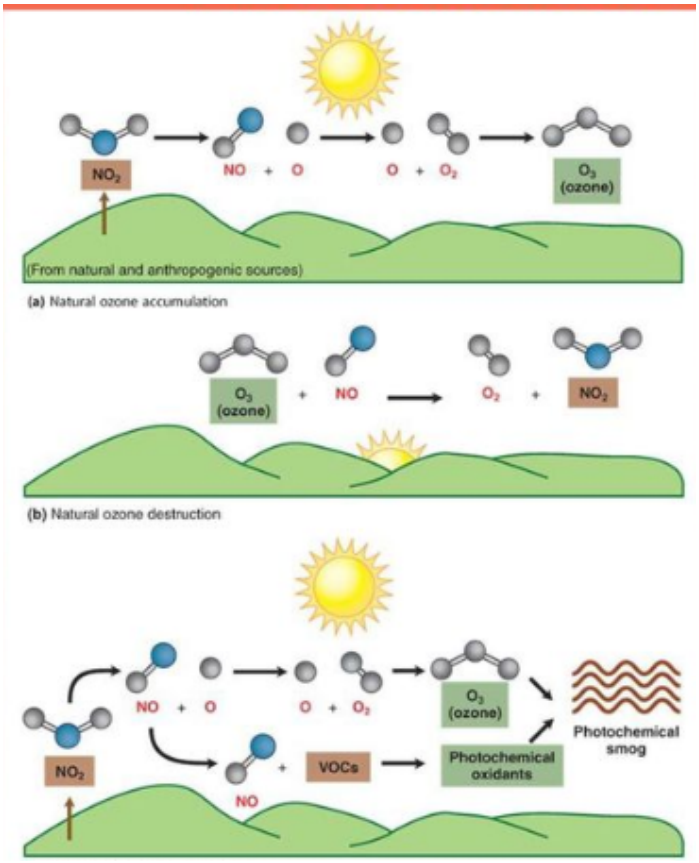
| | | |
|---|---|---|
| Pollutants | Primary air pollutant | Carbon Oxides |
| Air pollution | Secondary air pollutant | Hydrocarbons |
| Particulate matter | Mobile Sources | Ozone |
| Solid particulate matter | Stationary Sources | Stratosphere |
| Lead | Industrial Smog | Troposphere |
| Nitrogen Oxides (NOx) | Photochemical Smog | Vapor Recovery |
| Sulfur Oxides (SOx) | VOC's | UV Radiation |
| Clean Air Act | Temperature inversion | CFC's\ |
| Ozone thinning | Electrostatic Precipitator | Acid Deposition |
| Montreal Protocol | Scrubbers | Sick Building Syndrome |
| Forest Decline | Catalytic Converters | Radon |

Noise Pollution Light Pollution

Figures/ Equations to know

$SOx + H2O \rightarrow H2SO4$

$NOx + H2O \rightarrow HNO3$




## Transfer Goals

How do human activities contribute to atmospheric pollution.

Understand how materials move between the different spheres of the planet.

## Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

## Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=sharing