AP ENVIRONMENTAL SCIENCE

UNIT 7

Atmospheric Pollution

AP

7–10%
AP EXAM WEIGHTING

~11–12
CLASS PERIODS

Remember to go to **AP Classroom** to assign students the online **Personal Progress Check** for this unit.

Whether assigned as homework or completed in class, the **Personal Progress Check** provides each student with immediate feedback related to this unit's topics and skills.

Personal Progress Check 7

Multiple-choice: ~20 questions
Free-response: 1 question

- Design an investigation

Atmospheric Pollution

← → Building Understanding

Air pollution has many sources and effects, both indoors and outdoors. Air is a natural resource that covers the Earth and crosses many system boundaries. Human activities affect the quality of the air both indoors and outdoors. Through legislation, the Clean Air Act regulates the emission of air pollutants that affect human health. The gases and particulates in the atmosphere come from both natural and human sources; once air pollution sources are identified, methods can be used to reduce it. Subsequent units will focus on pollution's impacts to land and water.

Building the Science Practices

5.B 5.C 7.D

In this unit, students can practice comparing and predicting patterns and/or trends in a graph or table to explain how the data or representation illustrates environmental concepts. They can also practice drawing conclusions about an environmental concept based on a comparison of the patterns and trends in a graph or table.

Students can also practice proposing solutions to combat the effects of air pollution on human health and, most importantly, using data or evidence to support their solutions. In order to understand the implications of environmental legislation, it is important to know how environmental policies are applied and what the outcomes are in a variety of contexts. With that knowledge, students can then explain why those outcomes occurred and how the policy affected the outcomes.

Preparing for the AP Exam

On the AP Exam, students must be able to describe or identify a research method used to understand air pollution. They will also have to explain the patterns and trends in data related to air pollution and describe the relationship among variables of data represented graphically. Students may benefit from time in class devoted to hands-on laboratory activities related to air pollution. Teachers can also provide students practice in identifying information from graphs, diagrams, or infographics related to air pollution. Students often struggle to identify specific air pollutants and related illnesses. To combat this, teacher can provide opportunities for students to identify air pollutants and their impacts on human health.

UNIT AT A GLANCE

Enduring Understanding	Topic	Suggested Skill	Class Periods ~**11–12** CLASS PERIODS
STB-2	**7.1 Introduction to Air Pollution**	**4.E** Explain modifications to an experimental procedure that will alter results.	
	7.2 Photochemical Smog	**5.B** Describe relationships among variables in data represented.	
	7.3 Thermal Inversion	**2.C** Explain how environmental concepts and processes represented visually relate to broader environmental issues.	
	7.4 Atmospheric CO_2 and Particulates	**4.C** Describe an aspect of a research method, design, and/or measure used.	
	7.5 Indoor Air Pollutants	**5.C** Explain patterns and trends in data to draw conclusions.	
	7.6 Reduction of Air Pollutants	**7.D** Use data and evidence to support a potential solution.	
	7.7 Acid Rain	**4.B** Identify a research method, design, and/or measure used.	
	7.8 Noise Pollution	**3.C** Describe the author's reasoning (use of evidence to support a claim).	

AP
Go to **AP Classroom** to assign the **Personal Progress Check** for Unit 7.
Review the results in class to identify and address any student misunderstandings.

SAMPLE INSTRUCTIONAL ACTIVITIES

The sample activities on this page are optional and are offered to provide possible ways to incorporate various instructional approaches into the classroom. They were developed in partnership with teachers from the AP community to share ways that they approach teaching some of the topics in this unit. Please refer to the Instructional Approaches section beginning on p. 201 for more examples of activities and strategies.

Activity	Topic	Sample Activity
1	7.1	**Ask the Expert (or Students as Experts)** Divide students into five groups. Each group will become experts on the major criteria used to determine the air quality index (AQI): particulate matter, sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), and ozone (O_3). Have students rotate through expert stations to learn about how AQI is determined.
2	7.5	**Graph and Switch** Divide students into groups and have them assemble air traps by placing a small dab of petroleum jelly on an index card. Have them place the cards in different locations. Then have them collect the traps and analyze the different PM products collected in the trap by observing a sample under a stereomicroscope. Ask students to graph their data and share with the rest of the class.
3	7.6	**Idea Spinner** Provide students with information on global climate change and the effects of increasing CO_2 emissions on oceans and climate. Divide students into groups and give them a spinner with four quadrants labeled "Predict," "Explain," "Summarize," and "Evaluate." Have students take turns spinning the idea spinner and communicating their thoughts within the group.
4	7.7	**Graph and Switch** Have students add vinegar (simulated acid rain) to chalk (simulated limestone) and calculate the rates of decomposition on different-sized pieces of chalk over time. Then have them create graphs and analyze each other's data.

✎ Unit Planning Notes

Use the space below to plan your approach to the unit.

....

....

....

SUGGESTED SKILL

✕ *Scientific Experiments*

`4.E`

Explain modifications to an experimental procedure that will alter results.

▤

AVAILABLE RESOURCES
- Classroom Resource > **AP Environmental Science Teacher's Guide**
- The Exam > **Chief Reader Report 2018, Q4**
- The Exam > **Student Performance Q&A 2016, Q3**
- The Exam > Samples and Commentary (**2018, Q4**, **2016, Q3**)

TOPIC 7.1
Introduction to Air Pollution

Required Course Content

ENDURING UNDERSTANDING

`STB-2`

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

LEARNING OBJECTIVE

`STB-2.A`

Identify the sources and effects of air pollutants.

ESSENTIAL KNOWLEDGE

`STB-2.A.1`

Coal combustion releases air pollutants including carbon dioxide, sulfur dioxide, toxic metals, and particulates.

`STB-2.A.2`

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.

`STB-2.A.3`

Air quality can be affected through the release of sulfur dioxide during the burning of fossil fuels, mainly diesel fuels.

`STB-2.A.4`

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.

`STB-2.A.5`

Air pollutants can be primary or secondary pollutants.

TOPIC 7.2
Photochemical Smog

Required Course Content

ENDURING UNDERSTANDING

STB-2

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

LEARNING OBJECTIVE

STB-2.B

Explain the causes and effects of photochemical smog and methods to reduce it.

ESSENTIAL KNOWLEDGE

STB-2.B.1

Photochemical smog is formed when nitrogen oxides and volatile organic hydrocarbons react with heat and sunlight to produce a variety of pollutants.

STB-2.B.2

Many environmental factors affect the formation of photochemical smog.

STB-2.B.3

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.

STB-2.B.4

Volatile Organic Compounds (VOCs), such as formaldehyde and gasoline, evaporate or sublimate at room temperature. Trees are a natural source of VOCs.

STB-2.B.5

Photochemical smog often forms in urban areas because of the large number of motor vehicles there.

LEARNING OBJECTIVE

STB-2.B

Explain the causes and effects of photochemical smog and methods to reduce it.

ESSENTIAL KNOWLEDGE

STB-2.B.6

Photochemical smog can be reduced through the reduction of nitrogen oxide and VOCs.

STB-2.B.7

Photochemical smog can harm human health in several ways, including causing respiratory problems and eye irritation.

TOPIC 7.3
Thermal Inversion

Required Course Content

ENDURING UNDERSTANDING

`STB-2`

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

LEARNING OBJECTIVE

`STB-2.C`

Describe thermal inversion and its relationship with pollution.

ESSENTIAL KNOWLEDGE

`STB-2.C.1`

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.

`STB-2.C.2`

Thermal inversion traps pollution close to the ground, especially smog and particulates.

SUGGESTED SKILL

✎ *Visual Representations*

`2.C`

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

AVAILABLE RESOURCES

- Classroom Resource > **AP Environmental Science Teacher's Guide**

SUGGESTED SKILL

✖ *Scientific Experiments*

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

📄

AVAILABLE RESOURCES
▪ Classroom Resource >
  AP Environmental Science Teacher's Guide

TOPIC 7.4
Atmospheric CO$_2$ and Particulates

Required Course Content

ENDURING UNDERSTANDING

STB-2

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

LEARNING OBJECTIVE

STB-2.D
Describe natural sources of CO$_2$ and particulates.

ESSENTIAL KNOWLEDGE

STB-2.D.1
CO$_2$ appears naturally in the atmosphere from sources such as respiration, decomposition, and volcanic eruptions.

STB-2.D.2
There are a variety of natural sources of particulate matter.

TOPIC 7.5
Indoor Air Pollutants

SUGGESTED SKILL

✎ *Data Analysis*

5.C
Explain patterns and trends in data to draw conclusions.

📄

AVAILABLE RESOURCES
- Classroom Resource > **AP Environmental Science Teacher's Guide**
- The Exam > **Chief Reader Report 2018, Q1**
- The Exam > Student Performance Q&A (**2016, Q3**, **2014, Q1**)
- The Exam > Samples and Commentary (**2018, Q1**, **2016, Q3**, **2014, Q1**)

Required Course Content

ENDURING UNDERSTANDING

STB-2

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

LEARNING OBJECTIVE

STB-2.E
Identify indoor air pollutants.

ESSENTIAL KNOWLEDGE

STB-2.E.1
Carbon monoxide is an indoor air pollutant that is classified as an asphyxiant.

STB-2.E.2
Indoor air pollutants that are classified as particulates include asbestos, dust, and smoke.

STB-2.E.3
Indoor air pollutants can come from natural sources, human-made sources, and combustion.

STB-2.E.4
Common natural source indoor air pollutants include radon, mold, and dust.

STB-2.E.5
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.

STB-2.E.6
Common combustion air pollutants include carbon monoxide, nitrogen oxides, sulfur dioxide, particulates, and tobacco smoke.

LEARNING OBJECTIVE

STB-2.E
Identify indoor air pollutants.

STB-2.F
Describe the effects of indoor air pollutants.

ESSENTIAL KNOWLEDGE

STB-2.E.7
Radon-222 is a naturally occurring radioactive gas that is produced by the decay of uranium found in some rocks and soils.

STB-2.F.1
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.

STB-2.F.2
Exposure to radon gas can lead to radon-induced lung cancer, which is the second leading cause of lung cancer in America.

TOPIC 7.6
Reduction of Air Pollutants

Required Course Content

ENDURING UNDERSTANDING

STB-2

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

LEARNING OBJECTIVE

STB-2.G

Explain how air pollutants can be reduced at the source.

ESSENTIAL KNOWLEDGE

STB-2.G.1

Methods to reduce air pollutants include regulatory practices, conservation practices, and alternative fuels.

STB-2.G.2

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.

STB-2.G.3

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).

STB-2.G.4

Wet and dry scrubbers are air pollution control devices that remove particulates and/or gases from industrial exhaust streams.

STB-2.G.5

Methods to reduce air pollution from coal-burning power plants include scrubbers and electrostatic precipitators.

SUGGESTED SKILL

⚒ *Environmental Solutions*

7.D

Use data and evidence to support a potential solution.

AVAILABLE RESOURCES
- Classroom Resource > **AP Environmental Science Teacher's Guide**
- The Exam > **Chief Reader Report 2018, Q1**
- The Exam > **Student Performance Q&A 2016, Q3**
- The Exam > Samples and Commentary (**2018, Q1**, **2016, Q3**)

TOPIC 7.7
Acid Rain

Required Course Content

ENDURING UNDERSTANDING

STB-2
Human activities have physical, chemical, and biological consequences for the atmosphere.

LEARNING OBJECTIVE

STB-2.H
Describe acid deposition.

ESSENTIAL KNOWLEDGE

STB-2.H.1
Acid rain and deposition is due to nitrogen oxides and sulfur oxides from anthropogenic and natural sources in the atmosphere.

STB-2.H.2
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.

STB-2.I
Describe the effects of acid deposition on the environment.

STB-2.I.1
Acid deposition mainly affects communities that are downwind from coal-burning power plants.

STB-2.I.2
Acid rain and deposition can lead to the acidification of soils and bodies of water and corrosion of human-made structures.

STB-2.I.3
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.

TOPIC 7.8
Noise Pollution

Required Course Content

ENDURING UNDERSTANDING

STB-2

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

LEARNING OBJECTIVE

STB-2.J

Describe human activities that result in noise pollution and its effects.

ESSENTIAL KNOWLEDGE

STB-2.J.1

Noise pollution is sound at levels high enough to cause physiological stress and hearing loss.

STB-2.J.2

Sources of noise pollution in urban areas include transportation, construction, and domestic and industrial activity.

STB-2.J.3

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.