

## Module 3 Task

Module 3: Air Pollution

Unit 7 (p. 137)

- 1) **Graph and Switch.** Select 5 countries from the world map by clicking on them. Scroll down to the now-filtered ranking selection at the bottom of the app. Create a visually compelling representation of this table data that demonstrate how your 5 countries' statistics. Trade with a partner to identify how their countries compare/contrast.
- 2) **Error Analysis.** Analyze the "For all Countries" line graph and be sure that all 229 countries are selected. Provide critical feedback supported with specific data points to the statement, "The overall average 29-year exposure has not changed since 1990."
- 3) **One-Minute Essay.** Use your initial response in number 2, as well as data points from the ranked countries section below the line graph, to expound on the change over time of exposure to and % change in air pollution throughout the world. Based on your prior knowledge, provide potential factors that could be confounding (or obscuring) progress being made with pollution policies from overall countries report from the original line graph.

**DATA SCIENCE**  
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AP<sup>®</sup>

**INCLUDES**

- ✓ Course framework
- ✓ Instructional section
- ✓ Sample exam questions

# AP<sup>®</sup> Environmental Science

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**COURSE AND EXAM DESCRIPTION**

**Effective  
Fall 2020**

# Instructional Strategies

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The AP Environmental Science course framework outlines the concepts and skills students need to master to be successful on the AP Exam. In order to address those concepts and skills effectively, it helps

to incorporate a variety of instructional approaches into daily lessons and activities. The following table presents strategies that can help students apply their understanding of course concepts.

Strategy	Definition	Purpose	Example
<b><i>Ask the Expert (or Students as Experts)</i></b>	Students are assigned as “experts” on problems they have mastered; groups rotate through the expert stations to learn about problems they have not yet mastered.	Provides opportunities for students to share their knowledge and learn from one another.	Assign students as “experts” on environmental legislation. Have students rotate through stations in groups, working with the station expert to complete a series of questions on the topic.
<b><i>Construct an Argument</i></b>	Students use scientific reasoning to present assumptions about biological situations, support conjectures with scientifically relevant and accurate data, and provide a logical progression of ideas leading to a conclusion that makes sense.	Helps develop the process of evaluating scientific information, developing reasoning skills, and enhancing communication skills in supporting conjectures and conclusions.	Present students with a written or visual scenario of the results of a laboratory investigation and then have them work together to draw conclusions about scientific investigations. They can support their conclusions with data by having each student or group of students add a sentence to the conclusion. Once the conclusion is complete, read it (or show it on a screen) and then facilitate a class discussion.
<b><i>Debate</i></b>	Engaging in an informal or formal argumentation of an issue.	Provides an opportunity for students to collect and orally present evidence supporting the affirmative and negative arguments of a proposition or issue.	Have students debate realistic solutions to environmental problems. This can be more meaningful for students if the problem selected is specific to the school and students have the opportunity to present their solutions to school administrators.

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<b>Strategy</b>	<b>Definition</b>	<b>Purpose</b>	<b>Example</b>
<b>Error Analysis</b>	Students analyze an existing solution to determine whether (or where) errors have occurred.	Allows students to troubleshoot errors and focus on solutions that may arise when they do the same procedures themselves.	Have students analyze their work to determine whether their answer is realistic. For example, if they are working on an energy calculation, they can't end up with more energy than they started with.
<b>Fishbowl</b>	Some students form an inner circle and model appropriate discussion techniques, while an outer circle of students listens, responds, and evaluates.	Provides students with an opportunity to engage in a formal discussion and to experience the roles of both participant and active listener; students also have the responsibility of supporting their opinions and responses using specific evidence.	Divide students into two groups and ask them to form two concentric circles. The inner circle can explain ecosystem services to the students in the outer circle, and the outer circle can explain ecological services to students in the inner circle. The circles rotate to enable students to share their knowledge and learn to communicate with their peers.
<b>Graph and Switch</b>	Generating a graph to represent data and then switch papers to review each other's representations.	Allows students to practice creating different representations of data and both give and receive feedback on each other's work.	Give students a data table and ask them to graph the data. Then have them switch papers and offer one another feedback on whether they graphed the data appropriately. This can be scaffolded by distributing multiple data tables that require different types of graphs.
<b>Idea Spinner</b>	The teacher creates a spinner marked into four quadrants and labeled "Predict," "Explain," "Summarize," and "Evaluate." After new material is presented, the teacher spins the spinner and asks students to answer a question based on the location of the spinner. For example, if the spinner lands in the "Summarize" quadrant, the teacher might say, "List the key concepts just presented."	Functions as a formative assessment technique.	Present students with a written or visual scenario of the results of a laboratory investigation. Using the spinner, ask students to predict what would happen if one of the experimental conditions changed, explain the results, summarize the results, and evaluate the methods used.

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Strategy	Definition	Purpose	Example
<b><i>Index Card Summaries/ Questions</i></b>	Periodically, distribute index cards and ask students to write on both sides, with these instructions: (Side 1) Based on our study of (unit topic), list a big idea that you understand and word it as a summary statement. (Side 2) Identify something about (unit topic) that you do not yet fully understand and word it as a statement or question.	Functions as a formative assessment technique.	At the beginning or end of class, show students an image of food chains or food webs. On one side of an index card, have students summarize energy flow through ecosystems. On the other side, have them write a question they have about the topic. Collect the cards and read through them, noting any trends in student responses. Address all questions that day (if done at the beginning of class) or the next day (if given at the end of class).
<b><i>Misconception Check</i></b>	Present students with common or predictable misconceptions about a designated concept, principle, or process. Ask them whether they agree or disagree and to explain why. The misconception check can also be presented in the form of a multiple-choice or true or false quiz.	Functions as a formative assessment technique.	Provide students with a statement on the board, or on paper, such as, "Climate change and ozone depletion are the same." Ask them whether the statement is true or false and then ask them to explain their reasoning. Address any misconceptions according to the answers they give.
<b><i>One-Minute Essay</i></b>	A one-minute essay question (or a one-minute question) is a focused question with a specific goal that can, in fact, be answered within a minute or two.	Functions as a formative assessment technique.	Give students one minute to respond to a prompt, such as, "Explain the relationship between photosynthesis at the cellular level and environmental carbon cycling."
<b><i>Quickwrite</i></b>	Writing for a short, specific amount of time about a designated topic related to a text.	Helps students generate multiple ideas in a quick fashion that could be turned into longer pieces of writing at a later time (may be considered as part of the drafting process).	Prior to teaching about endangered species, ask students to take a few minutes to explain whether the Endangered Species Act is necessary. At the conclusion of the lesson, students can revisit their answer and revise it to reflect what they learned.

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Strategy	Definition	Purpose	Example
<b><i>Think–Pair–Share</i></b>	Considering and thinking about a topic or question and then writing what has been learned; pairing with a peer or a small group to share ideas; and sharing ideas and discussion with a larger group.	Helps students to construct meaning about a topic or question; test thinking in relation to the ideas of others; and prepare for a discussion with a larger group.	When engaging students in a post-lab discussion, have students reflect on their analysis of the data by asking them, “What is the relationship between the dependent variable and the independent variable?” After 1–2 minutes of reflection, have students turn to a neighbor and share their answer. After 2–3 minutes of sharing, engage the class in a whole-group discussion to ensure that students are building the necessary foundational understandings.

# Atmospheric Pollution

## BIG IDEA 4

### Sustainability **STB**

Where does air pollution go once it is airborne?



## 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.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 <sub>2</sub> 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).	
	Go to <a href="#">AP Classroom</a> to assign the <b>Personal Progress Check</b> 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	<b>Ask the Expert (or Students as Experts)</b> 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 <sub>2</sub> ), carbon monoxide (CO), nitrogen dioxide (NO <sub>2</sub> ), and ozone (O <sub>3</sub> ). Have students rotate through expert stations to learn about how AQI is determined.
2	7.5	<b>Graph and Switch</b> 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	<b>Idea Spinner</b> Provide students with information on global climate change and the effects of increasing CO <sub>2</sub> 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	<b>Graph and Switch</b> 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.

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## 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

## SUGGESTED SKILL

 Data Analysis**5.B**

Describe relationships among variables in data represented.



## AVAILABLE RESOURCES

Classroom Resource &gt;

[AP Environmental Science Teacher's Guide](#)

## 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 sublime 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.

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**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

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](#)

## 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

 *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<sub>2</sub> 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<sub>2</sub> and particulates.

### ESSENTIAL KNOWLEDGE

**STB-2.D.1**

CO<sub>2</sub> 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.



### 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.

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**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](#))

**LEARNING OBJECTIVE**

STB-2.E

Identify indoor air pollutants.

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

## SUGGESTED SKILL

 *Environmental Solutions*

## 7.D

Use data and evidence to support a potential solution.



## 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, NO<sub>x</sub>, and hydrocarbons) in exhaust into less harmful molecules (CO<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, and H<sub>2</sub>O).

## 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.

## AVAILABLE RESOURCES

Classroom Resource &gt;

[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](#))

## SUGGESTED SKILL

 *Scientific Experiments*

## 4.B

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



## AVAILABLE RESOURCES

Classroom Resource &gt;

[AP Environmental Science Teacher's Guide](#)

External Resource &gt;

[Environmental Literacy Council's AP Environmental Science Course Material](#)

## 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.

**STB-2.I**

Describe the effects of acid deposition on the environment.

### 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.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

SUGGESTED SKILL

 Text Analysis

**3.C**

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



AVAILABLE RESOURCES

Classroom Resource >

[AP Environmental Science Teacher's Guide](#)

## 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.

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