AP ENVIRONMENTAL SCIENCE

UNIT 9

Global Change

15–20%
AP EXAM WEIGHTING

~19–20
CLASS PERIODS

UNIT 9

15–20% AP EXAM WEIGHTING | **~19–20** CLASS PERIODS

Global Change

BIG IDEA 3
Interactions Between Different Species and the Environment EIN
- Why are laws created to protect endangered species?

BIG IDEA 2
Sustainability STB
- How can local human activities have a global impact?

Building Understanding

A central aspect of environmental science is to understand the global impact of local and regional human activities. Humans can mitigate their impact through sustainable use of resources. Human activities can cause ozone depletion in the stratosphere and increases in the greenhouse gases in the atmosphere. Increases in greenhouse gases can cause human health and environmental problems. These environmental problems include global climate change, ocean warming, and endangered species. Overall, this course provides an opportunity to examine the interrelationships among the natural world and challenges students to evaluate and propose solutions to a variety of environmental problems.

Building the Science Practices

1.A 1.B 1.C 7.A 7.B 7.C 7.D 7.E

In this final unit, the goal is for students to describe and explain global changes in the environment, the causes of these changes, and their consequences. Students can build on their skills from previous units, where they described and evaluated solutions, to propose their own solutions as they learn about problems caused by global changes in the environment. They can practice using data as evidence to support their proposed solution or legislation. Students can also explain how the solution or legislation solves the problem in question.

Preparing for the AP Exam

On the AP Exam, students often struggle with discussing strategies that would prevent extinction. Students are able to identify a strategy, but they are not able to explain how the strategy could be implemented to prevent extinction. Students incorrectly imply that small populations are threatened populations. To combat this, teachers can provide opportunities for students to read multiple sources that allow them to propose realistic solutions that would prevent the extinction of certain species. Students may benefit from opportunities to explain the advantages, disadvantages, or unintended consequences of efforts to prevent extinction.

Students also confuse the terms global climate change and ozone depletion. Teachers can provide multiple opportunities to practice using scientific vocabulary in the proper context in verbal and written explanations of environmental concepts. Diagrams and models that illustrate global climate change can also be helpful. Emphasis can be placed on the effects of global climate change with visual representations of changes over time. Students can then explain how the visual representation illustrates an environmental science concept or process.

SUGGESTED SKILL

Concept Explanation

1.A

Describe environmental concepts and processes.

AVAILABLE RESOURCES

- Classroom Resource > **AP Environmental Science Teacher's Guide**
- External Resource > **Environmental Literacy Council's AP Environmental Science Course Material**
- External Source > **GLOBE for the Environmental Science Classroom**

TOPIC 9.1
Stratospheric Ozone Depletion

Required Course Content

ENDURING UNDERSTANDING

STB-4

Local and regional human activities can have impacts at the global level.

LEARNING OBJECTIVE

STB-4.A

Explain the importance of stratospheric ozone to life on Earth.

ESSENTIAL KNOWLEDGE

STB-4.A.1

The stratospheric ozone layer is important to the evolution of life on Earth and the continued health and survival of life on Earth.

STB-4.A.2

Stratospheric ozone depletion is caused by anthropogenic factors, such as chlorofluorocarbons (CFCs), and natural factors, such as the melting of ice crystals in the atmosphere at the beginning of the Antarctic spring.

STB-4.A.3

A decrease in stratospheric ozone increases the UV rays that reach the Earth's surface. Exposure to UV rays can lead to skin cancer and cataracts in humans.

TOPIC 9.2
Reducing Ozone Depletion

Required Course Content

ENDURING UNDERSTANDING

STB-4

Local and regional human activities can have impacts at the global level.

LEARNING OBJECTIVE

STB-4.B

Describe chemicals used to substitute for chlorofluorocarbons (CFCs).

ESSENTIAL KNOWLEDGE

STB-4.B.1

Ozone depletion can be mitigated by replacing ozone-depleting chemicals with substitutes that do not deplete the ozone layer. Hydrofluorocarbons (HFCs) are one such replacement, but some are strong greenhouse gases.

SUGGESTED SKILL

Environmental Solutions

7.B

Describe potential responses or approaches to environmental problems.

AVAILABLE RESOURCES

- Classroom Resource > AP Environmental Science Teacher's Guide
- External Resource > Environmental Literacy Council's AP Environmental Science Course Material
- External Source > GLOBE for the Environmental Science Classroom

SUGGESTED SKILL

Concept Explanation

1.B

Explain environmental concepts and processes.

AVAILABLE RESOURCES

- Classroom Resource > AP Environmental Science Teacher's Guide
- External Resource > Environmental Literacy Council's AP Environmental Science Course Material
- External Source > GLOBE for the Environmental Science Classroom

TOPIC 9.3
The Greenhouse Effect

Required Course Content

ENDURING UNDERSTANDING

STB-4

Local and regional human activities can have impacts at the global level.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
STB-4.C Identify the greenhouse gases.	STB-4.C.1 The principal greenhouse gases are carbon dioxide, methane, water vapor, nitrous oxide, and chlorofluorocarbons (CFCs). STB-4.C.2 While water vapor is a greenhouse gas, it doesn't contribute significantly to global climate change because it has a short residence time in the atmosphere. STB-4.C.3 The greenhouse effect results in the surface temperature necessary for life on Earth to exist.
STB-4.D Identify the sources and potency of the greenhouse gases.	STB-4.D.1 Carbon dioxide, which has a global warming potential (GWP) of 1, is used as a reference point for the comparison of different greenhouse gases and their impacts on global climate change. Chlorofluorocarbons (CFCs) have the highest GWP, followed by nitrous oxide, then methane.

TOPIC 9.4
Increases in the Greenhouse Gases

Required Course Content

ENDURING UNDERSTANDING

STB-4

Local and regional human activities can have impacts at the global level.

LEARNING OBJECTIVE

STB-4.E

Identify the threats to human health and the environment posed by an increase in greenhouse gases.

ESSENTIAL KNOWLEDGE

STB-4.E.1

Global climate change, caused by excess greenhouse gases in the atmosphere, can lead to a variety of environmental problems including rising sea levels resulting from melting ice sheets and ocean water expansion, and disease vectors spreading from the tropics toward the poles. These problems can lead to changes in population dynamics and population movements in response.

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
- External Resource > Environmental Literacy Council's AP Environmental Science Course Material
- External Source > GLOBE for the Environmental Science Classroom

SUGGESTED SKILL

Data Analysis

5.D

Interpret experimental data and results in relation to a given hypothesis.

AVAILABLE RESOURCES

- Classroom Resource > **AP Environmental Science Teacher's Guide**
- External Resource > **Environmental Literacy Council's AP Environmental Science Course Material**
- External Source > **GLOBE for the Environmental Science Classroom**
- The Exam > **Student Performance Q&A 2014, Q4**
- The Exam > **Samples and Commentary 2014, Q4**

TOPIC 9.5
Global Climate Change

Required Course Content

ENDURING UNDERSTANDING

STB-4

Local and regional human activities can have impacts at the global level.

LEARNING OBJECTIVE

STB-4.F

Explain how changes in climate, both short- and long-term, impact ecosystems.

ESSENTIAL KNOWLEDGE

STB-4.F.1

The Earth has undergone climate change throughout geologic time, with major shifts in global temperatures causing periods of warming and cooling as recorded with CO_2 data and ice cores.

STB-4.F.2

Effects of climate change include rising temperatures, melting permafrost and sea ice, rising sea levels, and displacement of coastal populations.

STB-4.F.3

Marine ecosystems are affected by changes in sea level, some positively, such as in newly created habitats on now-flooded continental shelves, and some negatively, such as deeper communities that may no longer be in the photic zone of seawater.

STB-4.F.4

Winds generated by atmospheric circulation help transport heat throughout the Earth. Climate change may change circulation patterns, as temperature changes may impact Hadley cells and the jet stream.

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LEARNING OBJECTIVE

STB-4.F

Explain how changes in climate, both short- and long-term, impact ecosystems.

ESSENTIAL KNOWLEDGE

STB-4.F.5

Oceanic currents, or the ocean conveyor belt, carry heat throughout the world. When these currents change, it can have a big impact on global climate, especially in coastal regions.

STB-4.F.6

Climate change can affect soil through changes in temperature and rainfall, which can impact soil's viability and potentially increase erosion.

STB-4.F.7

Earth's polar regions are showing faster response times to global climate change because ice and snow in these regions reflect the most energy back out to space, leading to a positive feedback loop.

STB-4.F.8

As the Earth warms, this ice and snow melts, meaning less solar energy is radiated back into space and instead is absorbed by the Earth's surface. This in turn causes more warming of the polar regions.

STB-4.F.9

Global climate change response time in the Arctic is due to positive feedback loops involving melting sea ice and thawing tundra, and the subsequent release of greenhouse gases like methane.

STB-4.F.10

One consequence of the loss of ice and snow in polar regions is the effect on species that depend on the ice for habitat and food.

SUGGESTED SKILL

Environmental Solutions

7.A

Describe environmental problems.

AVAILABLE RESOURCES

- Classroom Resource > AP Environmental Science Teacher's Guide
- External Resource > Environmental Literacy Council's AP Environmental Science Course Material

TOPIC 9.6
Ocean Warming

Required Course Content

ENDURING UNDERSTANDING

STB-4

Local and regional human activities can have impacts at the global level.

LEARNING OBJECTIVE

STB-4.G

Explain the causes and effects of ocean warming.

ESSENTIAL KNOWLEDGE

STB-4.G.1

Ocean warming is caused by the increase in greenhouse gases in the atmosphere.

STB-4.G.2

Ocean warming can affect marine species in a variety of ways, including loss of habitat, and metabolic and reproductive changes.

STB-4.G.3

Ocean warming is causing coral bleaching, which occurs when the loss of algae within corals cause the corals to bleach white. Some corals recover and some die.

TOPIC 9.7
Ocean Acidification

Required Course Content

ENDURING UNDERSTANDING

STB-4

Local and regional human activities can have impacts at the global level.

LEARNING OBJECTIVE

STB-4.H

Explain the causes and effects of ocean acidification.

ESSENTIAL KNOWLEDGE

STB-4.H.1

Ocean acidification is the decrease in pH of the oceans, primarily due to increased CO_2 concentrations in the atmosphere, and can be expressed as chemical equations.

STB-4.H.2

As more CO_2 is released into the atmosphere, the oceans, which absorb a large part of that CO_2, become more acidic.

STB-4.H.3

Anthropogenic activities that contribute to ocean acidification are those that lead to increased CO_2 concentrations in the atmosphere: burning of fossil fuels, vehicle emissions, and deforestation.

STB-4.H.4

Ocean acidification damages coral because acidification makes it difficult for them to form shells, due to the loss of calcium carbonate.

SUGGESTED SKILL

Concept Explanation

1.C

Explain environmental concepts, processes, or models in applied contexts.

AVAILABLE RESOURCES

- Classroom Resource > AP Environmental Science Teacher's Guide
- External Resource > Environmental Literacy Council's AP Environmental Science Course Material

SUGGESTED SKILL

Environmental Solutions

7.E

Make a claim that proposes a solution to an environmental problem in an applied context.

AVAILABLE RESOURCES

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

TOPIC 9.8
Invasive Species

Required Course Content

ENDURING UNDERSTANDING

EIN-4

The health of a species is closely tied to its ecosystem, and minor environmental changes can have a large impact.

LEARNING OBJECTIVE

EIN-4.A

Explain the environmental problems associated with invasive species and strategies to control them.

ESSENTIAL KNOWLEDGE

EIN-4.A.1

Invasive species are species that can live, and sometimes thrive, outside of their normal habitat. Invasive species can sometimes be beneficial, but they are considered invasive when they threaten native species.

EIN-4.A.2

Invasive species are often generalist, r-selected species and therefore may outcompete native species for resources.

EIN-4.A.3

Invasive species can be controlled through a variety of human interventions.

TOPIC 9.9 Endangered Species

Required Course Content

ENDURING UNDERSTANDING

EIN-4

The health of a species is closely tied to its ecosystem, and minor environmental changes can have a large impact.

LEARNING OBJECTIVE

EIN-4.B

Explain how species become endangered and strategies to combat the problem.

ESSENTIAL KNOWLEDGE

EIN-4.B.1

A variety of factors can lead to a species becoming threatened with extinction, such as being extensively hunted, having limited diet, being outcompeted by invasive species, or having specific and limited habitat requirements.

EIN-4.B.2

Not all species will be in danger of extinction when exposed to the same changes in their ecosystem. Species that are able to adapt to changes in their environment or that are able to move to a new environment are less likely to face extinction.

EIN-4.B.3

Selective pressures are any factors that change the behaviors and fitness of organisms within an environment.

EIN-4.B.4

Species in a given ecosystem compete for resources like territory, food, mates, and habitat, and this competition may lead to endangerment or extinction.

EIN-4.B.5

Strategies to protect animal populations include criminalizing poaching, protecting animal habitats, and legislation.

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**
- External Resource > **Environmental Literacy Council's AP Environmental Science Course Material**
- External Resource > **GLOBE for the Environmental Science Classroom**
- The Exam > **Chief Reader Report 2017, Q2**
- The Exam > **Student Performance Q&A 2016, Q1**
- The Exam > Samples and Commentary (**2017, Q2**, **2016, Q1**)

SUGGESTED SKILL

Environmental Solutions

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

AVAILABLE RESOURCES

- Classroom Resource > AP Environmental Science Teacher's Guide

TOPIC 9.10
Human Impacts on Biodiversity

Required Course Content

ENDURING UNDERSTANDING

EIN-4

The health of a species is closely tied to its ecosystem, and minor environmental changes can have a large impact.

LEARNING OBJECTIVE

EIN-4.C

Explain how human activities affect biodiversity and strategies to combat the problem.

ESSENTIAL KNOWLEDGE

EIN-4.C.1

HIPPCO (habitat destruction, invasive species, population growth, pollution, climate change, and over exploitation) describes the main factors leading to a decrease in biodiversity.

EIN-4.C.2

Habitat fragmentation occurs when large habitats are broken into smaller, isolated areas. Causes of habitat fragmentation include the construction of roads and pipelines, clearing for agriculture or development, and logging.

EIN-4.C.3

The scale of habitat fragmentation that has an adverse effect on the inhabitants of a given ecosystem will vary from species to species within that ecosystem.

EIN-4.C.4

Global climate change can cause habitat loss via changes in temperature, precipitation, and sea level rise.

EIN-4.C.5

Some organisms have been somewhat or completely domesticated and are now managed for economic returns, such as honeybee colonies and domestic livestock. This domestication can have a negative impact on the biodiversity of that organism.

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LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
EIN-4.C Explain how human activities affect biodiversity and strategies to combat the problem.	**EIN-4.C.6** Some ways humans can mitigate the impact of loss of biodiversity include creating protected areas, use of habitat corridors, promoting sustainable land use practices, and restoring lost habitats.