**Westerville City Schools**
**Advanced Placement (AP) Environmental Science**
**Course of Study**
**Course Number: SC431**

## Course Description

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|---|---|
| **Recommended Grade Levels:** | 10-12 |
| **Recommended Prerequisite:** | Honors Biology/Biology |
| **Course Length:** | Full Year, 1 Period |
| **Credits:** | 1.0 Advanced Life Science |
| **Course Weighting:** | 1.25 |

Advanced Placement (AP) courses are designed to parallel the rigor of an introductory college course. Students in AP Environmental Science study interactions among and human influence on Earth systems, including natural resources and energy use and conservation, human and animal population dynamics, and environmental quality. AP Environmental Science involves “learning by doing” and incorporates scientific practices such as inquiry, experimental design, the use of models, data analysis, critical thinking, and using evidence to construct and communicate explanations.Students can expect to be using the outdoors as a learning environment when weather is appropriate.The AP test is administered in May. Students can earn college credit or advancement in college coursework with qualifying scores.

## Course Rationale

To uphold the district’s mission and foster college and career readiness, AP Environmental Science provides opportunities to develop highly transferable skills in collaboration, communication, creativity, and critical thinking which are relevant for any post-secondary coursework or career. The goal of AP Environmental Science is to provide students with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world, to identify and analyze environmental problems both natural and human-made, to evaluate the relative risks associated with these problems, and to examine alternative solutions for resolving or preventing them. AP Environmental Science will help prepare students pursuing careers in engineering, the natural sciences, politics, or any environmental field.

AP Environmental Science is a rigorous science course that stresses scientific principles and analysis and includes a laboratory component; it is intended to enable students to undertake, as first-year college students, a more advanced study of topics in environmental science or, alternatively, to fulfill a basic requirement for a laboratory science and thus free time for taking other courses.

## Considerations for Cultural Relevancy, Inclusivity, and Diversity:

Where possible teachers will create opportunities to incorporate the histories, values, beliefs and perspectives of people from different cultural backgrounds to meet the needs of all learners. Strategies for meeting the needs of all learners including gifted students, English Language Learners and students with disabilities can be found at this ODEW site.

## Considerations for Intervention and Acceleration:

This rigorous and highly relevant curriculum is built upon high quality, research-based instructional strategies.Teachers may need to provide targeted Tier II support (e.g., remediation of particular skills and concepts, as well as scaffolded or supplemental instruction) beyond the Tier I level of universal instruction to underachieving students. Intensive and individualized Tier III instruction (e.g., skill-specific intervention, one-on-one support).

## Scope and Sequence

| Unit | Approximate Length |
|---|---|
| 1 - Introduction to Earth and Environmental Science | 10 days |
| 2 - Introduction to the Living World and Ecology | 20 days |
| 3 - Introduction to Earth's Physical Systems | 20 days |
| 4 - Human Population | 15 days |
| 5 - Land and Water Use | 25 days |
| 6 - Energy Resources, Consumption and Conservation | 20 days |
| 7 - Pollution | 45 days |
| 8 - Global Change | 10 days |

## Expectations for Learning

The College Board has organized the AP Environmental Science course and exam around six unifying constructs or themes that cut across the many topics included in the study of environmental science. Units have been created that weave the unifying themes throughout the content. Content is to be studied within its own unit and related to other units via the unifying themes.

Unifying Themes:

1. Science is a process.
    a. Science is a method of learning more about the world.
    b. Science constantly changes the way we understand the world.

2. Energy conversions underlie all ecological processes.
    a. Energy cannot be created; it must come from somewhere.
    b. As energy flows through systems, at each step more of it becomes unusable.

3. The Earth itself is one interconnected system.
    a. Natural systems change over time and space.
    b. Biogeochemical systems vary in ability to recover from disturbances.

4. Humans alter natural systems.
    a. Humans have had an impact on the environment for millions of years.
    b. Technology and population growth have enabled humans to increase both the rate and scale of their impact on the environment.

5. Environmental problems have a cultural and social context.
    a. Understanding the role of cultural, social, and economic factors is vital to the development of solutions.

6. Human survival depends on developing practices that will achieve sustainable systems.
    a. A suitable combination of conservation and development is required.
    b. Management of common resources is essential.

## Portrait of a Successful AP Environmental Science Student

Westerville students successfully completing AP Environmental Science will . . .

Master college-level content of the following topics:

- population and community ecology
- interactions between and within Earth's physical systems
- human population growth and impacts
- historical, present and potential future uses of land and water
- energy sources, consumption, and sustainability
- pollution types, sources, impacts, and prevention
- historical, present, and potential future global changes seen in Earth's climate, as well as plant, animal, and human populations
- local, national and international environmental policy and law

Acquire the following skills:

- critical thinking
- collaboration
- problem solving
- field investigation techniques
- data collection and analysis
- organization and time management
- verbal and written communication through a variety of media and with multiple audiences

Develop the following attitudes/personal attributes:

- strong work ethic
- responsibility
- perseverance
- self-motivation
- open-mindedness

Have the following experiences:

- planning and executing field or lab-based open-ended investigations from start to finish
- using higher level thinking skills to apply engineering design principles to solve problems
- using proper field and laboratory equipment to execute freshmen college-level investigations
- producing argumentative and scientific writing pieces that justify claims with evidence and scientific reasoning

# College Board AP Environmental Science Content Standards

**Unit 1: Introduction to Earth and Environmental Science** (approximately 10 days)

**Enduring Understandings:**

- Understanding Earth's place in space and time frames our understanding of the environmental issues it faces today.
- Earth and its resources are protected by environmental regulations, laws, and treaties.

**Essential Questions:**

- How has Earth's position in the universe and its history before humans provided insight on addressing environmental issues faced today?
- How are our ecological footprints affecting Earth?
- How have historical efforts to protect the environment led to current environmental protection efforts?

**Learning Objectives:**

Seasons, Solar Intensity and Latitude

- Describe and build a model to explain the processes that result in seasons.
- Describe the relationship between solar intensity and latitude.
- Explain the Goldilocks Effect's impact on making Earth habitable.

Geologic Time

- List identifying characteristics about each major geologic time period.
- Connect plate tectonic activities to events in the geologic time scale.

History of Environmental Science and Laws

- Differentiate between environmental science and environmentalism.
- Explain the interdisciplinary nature of environmental science and the areas involved in the process of environmental decision making.
- Explain how humans place a value on the environment including the justifications of utilitarian, ecological, aesthetics, and moral values.
- Summarize the major historical trends in environmental science and policy.
- Identify, trace, and describe major U.S. environmental legislation.
- Identify and explain the role of the U.S. Environmental Protection Agency (EPA).
- Identify and analyze the challenges to environmental policy and decision making at the national and international levels.
- Discuss the achievements and factors influencing the achievements of international environmental policy.

**Vocabulary:**

advocacy, aesthetics, angle of incidence, axis, eon, era, ellipse, environmental science, environmentalism, equinox, geologic time scale, Goldilocks Effect, index fossils, insolation, latitude, longitude, morals, treaty, plate tectonics, revolution, rotation, solar intensity, solstice, specific heat, sustainability, utilitarian

**Assessments:**

Teacher created unit assessments with guidance from AP Environmental Science Teacher Community

**Unit 2: Introduction to the Living World and Ecology** (approximately 20 days)

**Enduring Understandings:**

- Organisms interact with each other and with Earth's systems.
- Ecosystems are the building blocks of the environment that contain biotic and abiotic factors interacting with each other.
- Biodiversity and evolution are critical parts of Earth's natural capital.

**Essential Questions:**

- How does the environment affect where and how an organism lives?
- How do organisms affect one another's survival and the environment?
- Why and how do biological communities change in response to changing environmental conditions?
- How are matter and energy conserved in an ecosystem?
- Why and how do organisms change over time?
- What makes an ecosystem diverse?

**Learning Objectives:**

<u>Ecosystem Structure</u>

- Define and discuss the concepts of ecology and environment including abiotic, biotic, and limiting factors, as well as ecosystem services.
- Define and differentiate between habitat and niche including examples of each and the interrelationship of habitat and niche.
- Identify, provide examples of, and discuss the roles (including keystone species) and kinds of interactions between organisms including predation, competition, and symbiosis.
- Define and discuss the interrelationship of organisms, communities, and ecosystems.
- Identify and describe the terrestrial and aquatic (fresh and saltwater) biomes.
- Compare and contrast the physical and biological characteristics of marine habitats (intertidal, continental shelf, benthic, euphotic, and pelagic zones, as well as upwellings and coral reefs).
- Explain the significance and functions of wetlands.

<u>Energy Flow</u>

- Trace and discuss the flow of energy through an ecosystem with specific reference to trophic levels, organisms of each trophic level, food chains, and food webs.
- Define, construct, and discuss food chains and food webs including the interrelationship of the elements of the food chains and webs.

<u>Natural Ecosystem Change</u>

- Using examples of successful ecological restoration projects, define, explain the role of, and describe the steps of restoration ecology.
- Identify, differentiate between, discuss the influential factors of, and provide examples of the stages of primary and secondary succession in terrestrial ecosystems.
- Identify, discuss, and give examples of the plant and animal species of the major types of terrestrial climax communities.
- Identify, differentiate between, discuss the influential factors of, and provide examples of the stages of primary and secondary succession in aquatic ecosystems.
- Identify, discuss, and give examples of the plant and animal species of the major types of aquatic climax communities.

<u>Population Biology</u>

- Define and differentiate between population and species.

- Provide examples of different reproductive and survival strategies that organisms have evolved over time.

Ecosystem Diversity

- Define and discuss natural selection, evolutionary patterns, and the interrelationship of each with the environment and environmental problems.
- Explain the role of mutations relative to species and species' survival.
- Differentiate between the different types of biodiversity.
- Provide justification for a ranking of terrestrial and aquatic biomes by biodiversity.
- Discuss extinction of species including examples and the factors causing extinctions.
- Describe the management of ecosystems for wildlife including migratory birds relative to habitat analysis, population assessment and predator or competitor control.

**Vocabulary:**
abiotic factors, adaptation, biodiversity, biome, biotic factors, climax community, commensalism, community, competition, consumer, decomposer, detritivore, ecosystem, ecosystem services, ecological diversity, edge effects, exploitation, food chain, food web, gross primary productivity (GPP), invasive species, k-strategist, keystone species, mutualism, natural selection, net primary productivity (NPP), niche (ecological, fundamental and realized), parasitism, pioneer species, population, primary succession, predation, producer, r-strategist, secondary succession, speciation, species, species diversity, symbiosis, terrestrial, trophic level

**Assessments:**
Teacher created unit assessments with guidance from AP Environmental Science Teacher Community

**Unit 3: Introduction to Earth's Physical Systems** (approximately 20 days)

**Enduring Understandings:**

- Earth is made of systems that interact to support life on Earth.
- Humans have impacted Earth's systems in both positive and negative ways.

**Essential Questions:**

- How do Earth's systems interact?
- How do the nonliving parts of Earth's systems provide the basic materials to support life?
- What are Earth's major geological processes and resources?
- What water resources are available to sustain life on Earth?
- How do factors such as solar intensity and climate affect atmospheric and oceanic circulation patterns?

**Learning Objectives:**

- Describe and provide examples of interactions between the atmosphere, hydrosphere, lithosphere, biosphere, and anthroposphere.

<u>Atmosphere</u>

- Explain the composition of Earth's atmosphere including the percentage of nitrogen, oxygen, water vapor, and other gases.
- Identify and describe the divisions of the atmosphere.
- Diagram and discuss how air circulation in the troposphere impacts climate at various latitudes.
- Explain the environmental impacts of the Coriolis Effect.

<u>Hydrosphere</u>

- Identify by percentage the location of the world's water with specific reference to oceans, atmosphere, groundwater, surface water, ice caps and glaciers.
- Compare the quantity and composition of freshwater and saltwater.
- Explain the groundwater flow system including the water table, aquifer, confined aquifer, unconfined aquifer, vadose zone, recharge area, aquiclude, aquitard, flowing artesian well, and non-flowing artesian well.
- Differentiate between an effluent stream, an influent stream, a perennial stream, and an ephemeral stream.
- Explain the ocean currents including the ocean conveyor and the effects of ocean circulation.

<u>Lithosphere</u>

- Describe the structure of Earth including the core, mantle, asthenosphere, lithosphere and crust.
- Identify the geologic cycles or processes that affect Earth's surface.
- Define and explain the tectonic cycle including identification of major tectonic plates.
- Explain the movements of the tectonic plates including divergent boundaries, convergent boundaries, and transform boundaries (faults).
- Explain the rock cycle including differentiation between sedimentary, igneous, and metamorphic rocks.
- Demonstrate and explain the effects of chemical weathering on three types of rocks.
- Discuss soil formation and the physical and chemical properties of different soil types.
- Discuss soil profile and differentiate between the layers (horizons) of soil.
- Explain the process of soil erosion and the effects of eroded soils.
- Demonstrate and explain a soil habitat by investigating the macroscopic and microscopic organisms of a soil sample or specific area (also in unit 2).

- Explain soil sustainability.

Biogeochemical Cycles

- Diagram and explain the major biogeochemical cycles (carbon, nitrogen, water, and phosphorus).
- Explain how humans affect each biogeochemical cycle and strategies to limit these effects.

**Relevant Vocabulary:**
acid deposition, anthroposphere, asthenosphere, aquiclude, aquitard, biogeochemical cycle, biosphere, carbon cycle, cementation, compaction, confined aquifer, convection cells, Coriolis effect, cryosphere, denitrification, ENSO, ephemeral stream, erosion, eutrophication, exosphere, feedback loop, flowing artesian well, gyre, horizon, humus, hydrosphere, igneous rock, lithosphere, mesosphere, metamorphic rock, nitrification, nitrogen fixation, non-flowing artesian well, nutrient cycling, phosphorus cycle, rain shadow, recharge area, runoff, sedimentary rock, stratosphere, tectonic forces, troposphere, unconfined aquifer, upwelling, vadose zone, weathering

**Assessments:**
Teacher created unit assessments with guidance from AP Environmental Science Teacher Community

**Unit 4: Human Population** (approximately 15 days)

**Enduring Understandings:**

- Plant, animal, and human populations interact with each other in a variety of ways that affect numbers of a given species or group.
- Human populations have a large impact on the global environment, and their sizes are influenced by many cultural, natural, and economic factors.

**Essential Questions:**

- What factors influence the growth or decline of populations?
- How do changes in population size relate to environmental conditions?
- How can our knowledge of human population demographics inform sustainability efforts?

**Learning Objectives:**

Population Biology

- Describe factors that influence a population's growth rate.
- Explain how limiting factors and biotic potential affect population growth.

Human Population Dynamics

- Use growth curves and identify influential factors to explain the growth of the human population over time.
- Compare and contrast the populations of the developed, developing, and underdeveloped countries including gender ratio, age distribution, birth rate, death rate, and life expectancy.
- Investigate determining factors of Earth's human population carrying capacity.
- Discuss reproductive strategies and birth control as observed in the developed, developing, and underdeveloped countries.
- Identify and discuss the causes of mortality in the developed, developing, and underdeveloped countries.

Impacts of Population Growth

- Analyze age structure diagrams to predict future population growth.
- Discuss global human populations with reference to growth influential factors, standards of living, demographic transitions, and the impact of these on resources.
- Define and explain the concept of sustainability inclusive of the interrelationship of sustainability, resources, economics, and development. (also in units 5 and 6)
- Differentiate between sustainable growth and sustainable use. (also in units 5 and 6)
- Explain sustainability from a global perspective. (also in units 5 and 6)

**Vocabulary:**

age distribution, age structure diagram, crude birth rate (CBR), carrying capacity, crude death rate (CDR), demography, demographic transition model, exponential growth, life expectancy, limiting factors, linear growth, migration, mortality, natality, net migration rate, population density, replacement level fertility rate (TFR), survivorship, sustainability, urbanization

**Assessments:**

Teacher created unit assessments with guidance from AP Environmental Science Teacher Community

**Unit 5: Land and Water Use** (approximately 25 days)

**Enduring Understandings:**

- Soil and water resources are vital to sustain different environments and to feed the people and animals of Earth.
- Economic and human needs can have great impacts on decisions regarding allocation of limited land and water resources use.
- Many different groups with different interests must determine best uses and practices of Earth's land and water resources.

**Essential Questions:**

- How can we balance our growing demand for food with our need to protect the environment?
- How can we balance needs for housing and jobs with the needs of the environment?
- How can we work on various scales (local to international) to best manage and sustain Earth's land and water resources?

**Learning Objectives:**

- Evaluate the effectiveness of preservation, remediation, mitigation, and restoration as various land and water conservation strategies.

<u>Agriculture</u>

- Analyze costs and benefits of agricultural strategies (polyculture, monoculture, slash and burn, contour farming, strip farming, terracing, no till farming) developed to feed a growing human population.
- Describe soil conservation practices of contour farming, strip farming, terracing, and no till farming.
- Explain industrial agriculture and the Green Revolution including the development of hybrids and genetic modification.
- Compare and contrast different irrigation strategies.
- Identify and describe the use of the agricultural chemicals of fertilizers and pesticides.
- Differentiate between and provide examples of persistent and nonpersistent pesticides.
- Explain the ecological approaches to agricultural pest control.
- Compare and contrast integrated pest management strategies in agriculture.
- Discuss the effect of agriculture on the biosphere.
- Explain the loss of farmland and the effect on the environment.
- Construct a model farm using sustainable agriculture strategies.

<u>Forestry</u>

- Describe soil conservation practices.
- Evaluate the causes and effects of deforestation.

<u>Rangeland</u>

- Explain the use of rangelands as grazing lands including advantages and disadvantages.
- Reference laws and regulations when describing rangeland management.

<u>Mining</u>

- Compare and contrast the formation, extraction, exploitation, use, recycling, and conservation of various mineral resources.
- Differentiate between and identify major locations of mineral reserves and mineral resources.
- Summarize relevant legislation related to mineral extraction.

<u>Other Land Uses</u>

- Explain the rural to urban shift in the United States including the growth of suburbs.

- Explain urban sprawl and the problems associated with unplanned urban growth.
- Contrast the loss of open space with the concept of urban green space.
- Analyze the ecosystem impact of different transportation infrastructures (highway systems, canals and channels, and non-motorized vehicle areas).
- Describe the types of federal lands (wilderness areas, national parks, wildlife refuges, national forests, and wetlands) and how each is protected and managed.
- Describe soil conservation practices.
- Discuss the loss of wetlands and the effect on the environment.
- Define a floodplain and cite specific examples to explain the problem of building on a floodplain.
- Explain land-use planning with specific reference to the need for planning and the implementation of land-use plans.

Water Use and Conservation

- Differentiate between potable and non-potable water.
- Discuss the kinds of water use in the world (domestic, agricultural, industrial, off-stream, and in-stream).
- Explain the significance of and challenges with the desalination process.
- Describe the effects of water dams and channelization of water on the environment (silting, flooding, thermal changes, and flood control strategies).
- Discuss water conservation with specific reference to agriculture, domestic, and industrial uses.
- Explain sustainability of water.
- Identify the major federal water legislation in the United States.

Fishing

- Compare and contrast different fishing techniques and their relationship to issues of overfishing.
- Discuss the condition and sustainability of the ocean and Great Lakes fisheries.
- Describe the mechanism, advantages, and disadvantages of aquaculture.
- Identify the major federal or state fishing regulations in the United States.

Integrated Concept: Global Economics and Impacts

- Discuss and explain the economic impacts of desertification.
- Analyze the environmental impacts of globalization.
- Describe the role of the World Bank in international affairs and its impact on local ecosystems.
- Define and explain the concept of sustainability inclusive of the interrelationship of sustainability, refute, resources, economics, and development. (also in units 4 and 6)
- Differentiate between sustainable growth and sustainable use. (also in units 4 and 6)
- Explain sustainability from a global perspective. (also in units 4 and 6)

**Vocabulary:**
aquaculture, by-catch, chemical pest control, Clean Water Act, clear-cutting, compost, deforestation, desalination, desertification, erosion, floodplain, genetically modified organism (GMO), globalization, greywater, Green Revolution, heat island, hydroponic agriculture, integrated pest management, intensive industrialized agriculture, mining, mitigation, National Environmental Policy Act (NEPA), non-potable, potable, preservation, rangeland management, remediation, restoration, salination, selective cutting, soil degradation, suburban sprawl, sustainability, Tragedy of the Commons, wildlife refuges, World Bank, urban sprawl, urbanization

**Assessments:**
Teacher created unit assessments with guidance from AP Environmental Science Teacher Community

**Unit 6: Energy Resources** (approximately 20 days)

**Enduring Understandings:**

- Nonrenewable energy has been providing power for human consumption for many years, but the sources of nonrenewable energy are being depleted.
- Renewable energy has emerged as an environmentally and sustainable alternative to fossil fuel use.
- Advantages and disadvantages of energy sources must be considered meeting current energy needs, planning for future energy needs, and protecting the environment.
- A balance between energy consumption and conservation must be met to foster sustainability on Earth.

**Essential Questions:**

- How is the environment affected by human energy use?
- How are fossil fuels currently being used - and how were they used in the past - to meet energy demands?
- How will we be able to depend on nonrenewable energy sources for our future energy needs?
- How can we transition to more sustainable energy usage?

**Learning Objectives:**

Energy Concepts

- Identify different forms of energy and their relationship to power and work.
- Apply the laws of thermodynamics to various energy production strategies.

Fossil Fuels for Energy

- Describe the formation and location of major reserves of coal (peat, lignite, bituminous, and anthracite), oil, and natural gas.
- Compare and contrast - as well as explain the environmental impact from - extracting, processing, delivering, and using fossil fuels.

Nuclear Energy

- Explain the development and uses of nuclear energy including radiation types, fission, and fusion.
- Identify and discuss worldwide nuclear reactors including the nuclear fuel cycle and the concerns (environmental and human health) associated with nuclear power.

Hydroelectric Power

- Discuss the mechanism of dams and how they supply electricity.

Renewable Energy

- Compare environmental advantages/disadvantages of different types of renewable energy sources (solar, solar thermal, hydrogen fuel cells, biomass, wind energy, small-scale hydroelectric, ocean waves, tidal energy, geothermal energy)

Integrated Concept: Environmental Advantages and Disadvantages of Energy Sources

- Identify and differentiate between renewable and nonrenewable resources, including the benefits and drawbacks of each type.

Integrated Concept: Energy Consumption

- Compare and contrast the world energy consumption by type.
- Compare and contrast historical, current, and future energy consumption trends throughout the regions of the world.
- Analyze and explain the interrelationship between energy , economic development, lifestyles, and current uses and demands.
- Delineate and explain the costs of resources utilization.

Integrated Concept: Energy Conservation

- Define, discuss the significance of, and cite examples of efforts to increase energy conservation.
- Summarize regulations and standards related to fuel economy in motor vehicles.
- Define and explain the concept of sustainability including the interrelationship of sustainability, resources, economics, and development. (also in units 4 and 5)
- Differentiate between sustainable growth and sustainable use. (also in units 4 and 5)
- Explain sustainability from a global perspective. (also in units 4 and 5)

**Vocabulary:**
biomass, Corporate Average Fuel Economy (CAFE), cogeneration, conservation, carbon footprint, efficiency, electrical grid, energy distribution, energy subsidies, fossil fuel, geothermal, green architecture, hydraulic fracturing, hydroelectric, hydrogen fuel cell, laws of thermodynamics, natural gas, nonrenewable energy, nuclear fission, nuclear fusion, petroleum, photovoltaic cells, radioactive waste, reactor, renewable energy, silting, solar-thermal, sustainability, tar sands, tidal energy, turbines, wave energy, wind energy, wind turbine

**Assessments:**
Teacher created unit assessments with guidance from AP Environmental Science Teacher Community

**Unit 7: Pollution** (approximately 45 days)

**Enduring Understandings:**

- Pollution affects the environment and human health.
- Air pollution and its sources are major contributors to today's environmental and health problems.
- Sustainable clean water is an essential resource for humans and ecosystems in all parts of the world.
- Strategies to effectively manage solid waste are necessary to protect humans and the environment from hazardous materials.

**Essential Questions:**

- How have various types of pollution affected humans and ecosystems?
- How can we ensure plants, animals and humans have clean air to breathe and clean water to drink?
- How can our choices as consumers and waste producers affect our environment?
- How can we best balance our own interests and needs with Earth's health?
- What is the relationship between environmental health and human health?

**Learning Objectives:**

- Use a cost-benefit analysis to evaluate the economic impacts of various types of pollution.
- Identify externalities and marginal social costs of various types of pollution.

<u>Air Pollution</u>

- Identify the major categories and sources of air pollution including natural and human sources.
- Identify and describe how the primary air pollutants (carbon monoxide, hydrocarbons, particulates, sulfur dioxide, and nitrogen compounds) are produced and the effects of each.
- Identify and describe how the secondary air pollutants (photochemical smog and ground level ozone) are produced and the effects of each.
- Explain the concept of greenhouse gases including the major components and their effects. (also in 8)
- Explain and cite examples of how an atmospheric inversion can cause a major pollution problem.
- Discuss gases and particulates as urban pollution.
- Identify the sources of acid rain.
- Explain how acid deposition and acid rain can be mitigated.
- Demonstrate and explain the effects of acid rain on the germination and growth of plants.
- Describe the sources and effects of and strategies to reduce tobacco smoke and radon as indoor air pollutants.
- Describe various mitigation and remediation strategies related to air pollution.
- Outline the historical progression of air pollution legislation, standards and the index of air quality.

<u>Water Pollution</u>

- Identify and describe the kinds and sources of water pollution.
- Differentiate between point sources and nonpoint sources of water pollution.
- Demonstrate and explain the effects of pollutants on biological organisms, particularly in relation to water quality.
- Diagram and describe wastewater treatment, including primary, secondary and tertiary processes.
- Explain the problem of ocean pollution with specific reference to toxic chemicals and plastics.

- Describe various mitigation and remediation strategies related to water pollution.

Noise Pollution
- Describe sources, explain effects, and identify measures put in place to control noise pollution.

Solid Waste
- Summarize early concepts and describe current methods of solid waste disposal in regions throughout the world.
- Describe how solid waste is a global issue.
- Demonstrate and explain the biological and biochemical functioning of a landfill by constructing, maintaining, and performing tests and measurements of an experimental miniature landfill.
- Discuss the interrelationship of municipal solid waste management and economics, technological changes, and citizen awareness and involvement.
- Describe various mitigation and remediation strategies related to solid waste disposal.

Hazardous Chemicals in the Environment
- Differentiate between hazardous and toxic materials, substances, and wastes.
- Identify and discuss the issues associated with the establishment of regulations for hazardous and toxic materials and substances.
- Compare and contrast past, current, and future plans for management of hazardous waste.
- Describe the relationship between hazardous waste and environmental degradation.
- Differentiate between and give examples of the effects of bioaccumulation and biomagnification.
- Describe various mitigation and remediation strategies related to hazardous waste.
- Identify hazardous waste legislation in the United States.

Pollution Hazards to Human Health
- Explain and cite examples of health risks associated with hazardous wastes and toxic effects.

**Vocabulary:**
acid deposition, acid rain, acute effects, antibiotic resistance, bioaccumulation, biological oxygen demand (BOD), biomagnification, carcinogen, chronic effects, Clean Water Act, cost benefit analysis, cultural eutrophication, deadzone, dose-response curve, effluent, epidemiology, greenwashing, ground level ozone, hazardous waste, industrial solid waste, incineration, integrated waste management, leaching, manure lagoon, municipal solid waste, mutagen, noise pollution, nonpoint source pollution, ozone, particulates, photochemical smog, point source pollution, primary treatment, radon gas, remediation, risk assessment, Safe Drinking Water Act, sanitary landfill, secondary treatment, septic systems, Superfund site, sustainability, teratogen, tertiary treatment, thermal inversion, toxicology, volatile organic compounds (VOCs), wastewater, World Health Organization

**Assessments:**
Teacher created unit assessments with guidance from AP Environmental Science Teacher Community

**Unit 8: Global Change** (approximately 10 days)

**Enduring Understandings:**

- Earth is undergoing change due to natural causes and human impact.
- Ozone depletion and climate change are major threats to a sustainable environment.
- Humans can affect the retention or loss of Earth's biodiversity depending on their actions and governmental policies.

**Essential Questions:**

- How can we best balance our own interests and needs with the health of the environment?
- How can we reduce our use of ozone depleting products and reduce greenhouse gas emissions to sustain the benefits of the ozone layer?
- What are the causes and consequences of Earth's changing climate?
- Why is it important to protect Earth's biodiversity?

**Learning Objectives:**

Stratospheric Ozone

- Explain the concept of greenhouse gases including the major components and their effects. (also in 7)
- Explain the significance of atmospheric ozone depletion including causing factors, environmental effects, and efforts to mitigate destruction of the ozone layer.

Global Warming

- Explain climate and climatic changes over time ranging from preglacial periods to the present.
- Describe the impacts of volcanic activities, ocean current circulation, greenhouse gases, and Earth's annual rotation around the sun on global climate changes.
- Compare and contrast the effects of climatic changes on sea levels, agriculture, water tables, individual organisms and entire ecosystems.
- Discuss global warming and its effects on human populations, global health, and global economics.
- Compare and contrast the effectiveness of various global warming mitigation and remediation strategies (including state, federal and international laws).

Loss of Biodiversity/Conservation

- Discuss the impact of humans on the natural ecosystems of the world with specific reference to forests, grasslands, wilderness and remote areas, freshwater environments, and the ocean.
- Differentiate between endangered and threatened species including examples of each.
- Discuss preventative and protective measures (including state, federal, and international laws) related to loss of biodiversity.

**Vocabulary:**

aerosols, anthropogenic, albedo effect, biodiversity, cap and trade, carbon capture and storage, chlorofluorocarbons, climate change, communal resource management system, Convention on International Trade in Endangered Species (CITES), ecojustice, environmental impact statement, ex-situ conservation, flagship species, frontier economy, global warming, globalization, greenhouse effect, greenhouse gas, habitat restoration, indicator species, in-situ conservation, intangible resources, invasive species, keystone species, Kyoto Protocol, known resources, Lacey Act, mitigation, Montreal Protocol, ocean acidification, open access system, ozone depletion, proven resources, recoverable resources, remediation, speculative resources, stratospheric ozone, tropospheric ozone, umbrella species

**Assessments:**
Teacher created unit assessments with guidance from AP Environmental Science Teacher Community

## Common Core State Standards - English/Language Arts

Teachers should incorporate the English/Language Arts Common Core State Standards throughout the course.

### *Reading*

*Key Ideas*

1. Cite specific textual evidence to support analysis of science and technical texts.
2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

*Craft and Structure*

1. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
2. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g. force, friction, reaction force, energy).
3. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

*Integration of Knowledge and Ideas*

1. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g. in a flowchart, diagram, model, graph, or table).
2. Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
3. Compare and contrast the information gained from experiments (including their own experiments), simulation, video, or multimedia sources with that gained from reading a text on the same topic.

### *Writing*

*Text Types and Purposes*

1. Write arguments focused on discipline-specific content.
    a. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
    b. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
    c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
    d. Establish and maintain a formal style.
    e. Provide a concluding statement or section that follows from and supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
    a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose, including graphics (e.g. charts, tables), formatting (e.g. headings), and multimedia when useful to aiding comprehension.
    b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
    c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to inform about or explain the topic.
e. Establish and maintain a formal style and objective tone.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented.

3. Students' narrative skills continue to grow throughout high school. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same result.

*Production and Distribution of Writing*

1. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
2. With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.
3. Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

*Research to Build and Present Knowledge*

1. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
2. Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
3. Draw evidence from informational texts to support analysis, reflection and research.
4. Write routinely over extended time frames (time for reflection and revision) and shorter time frames ( a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

## Board Adopted Instructional Materials

*Living in the Environment* by Miller and Spoolman, 2014, 18th edition, Cengage Learning, ISBN: 978-1133940135
includes Mindtap (online ancillary materials)

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