

ADVANCED PLACEMENT ENVIRONMENTAL SCIENCE

AP Environmental Science provides 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 and/or preventing them.

To ensure a complete and well-grounded experience, in addition to lab and classroom activities, the course includes an outdoor research component. Students will be expected to participate in scientific research of a nearby ecosystem. Every effort will be given to provide students with prior notice as to when a field trip will occur, however it is ultimately the student's responsibility to be prepared, dressing appropriately for various or unpredictable weather conditions.

I. Earth Systems and Resources

- A. Earth Science Concepts (geologic time scale; plate tectonics, earthquakes, volcanism; seasons; solar intensity and latitude)
- B. The Atmosphere (composition; structure; weather and climate; atmospheric circulation and the Coriolis Effect; atmosphere–ocean interactions; ENSO)
- C. Global Water Resources and Use (freshwater/saltwater; ocean circulation; agricultural, industrial, and domestic use; surface and groundwater issues; global problems; conservation)
- D. Soil and Soil Dynamics (rock cycle; formation; composition; physical and chemical properties; main soil types; erosion and other soil problems; soil conservation)

II. The Living World

- A. Ecosystem Structure (biological populations and communities; ecological niches; interactions among species; keystone species; species diversity and edge effects; major terrestrial and aquatic biomes)
- B. Energy Flow (photosynthesis and cellular respiration; food webs and trophic levels; ecological pyramids)
- C. Ecosystem Diversity (biodiversity; natural selection; evolution; ecosystem services)
- D. Natural Ecosystem Change (climate shifts; species movement; ecological succession)
- E. Natural Biogeochemical Cycles (carbon, nitrogen, phosphorus, sulfur, water, conservation of matter)

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III. Population

- A. Population Biology Concepts (population ecology; carrying capacity; reproductive strategies; survivorship)
- B. Human Population
 - 1. Human population dynamics (historical population sizes; distribution; fertility rates; growth rates and doubling times; demographic transition; age-structure diagrams)
 - 2. Population size (strategies for sustainability; case studies; national policies)
 - 3. Impacts of population growth (hunger; disease; economic effects; resource use; habitat destruction)

IV. Land and Water Use

- A. Agriculture
 - 1. Feeding a growing population (human nutritional requirements; types of agriculture; Green Revolution; genetic engineering and crop production; deforestation; irrigation; sustainable agriculture)
 - 2. Controlling pests (types of pesticides; costs and benefits of pesticide use; integrated pest management; relevant laws)
- B. Forestry (tree plantations; old growth forests; forest fires; forest management; national forests)
- C. Rangelands (overgrazing; deforestation; desertification; rangeland management; federal rangelands)
- D. Other Land Use
 - 1. Urban land development (planned development; suburban sprawl; urbanization)
 - 2. Transportation infrastructure (federal highway system; canals and channels; roadless areas; ecosystem impacts)
 - 3. Public and federal lands (management; wilderness areas; national parks; wildlife refuges; forests; wetlands)
 - 4. Land conservation options (preservation; remediation; mitigation; restoration)
 - 5. Sustainable land-use strategies
- E. Mining (Mineral formation; extraction; global reserves; relevant laws and treaties)
- F. Fishing (Fishing techniques; overfishing; aquaculture; relevant laws and treaties)
- G. Global Economics (Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

V. Energy Resources and Consumption

- A. Energy Concepts (energy forms; power; units; conversions; Laws of Thermodynamics)
- B. Energy Consumption

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1. History (Industrial Revolution; exponential growth; energy crisis)
 2. Present global energy use
 3. Future energy needs
- C. Fossil Fuel Resources and Use (formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synfuels; environmental advantages/ disadvantages of sources)
- D. Nuclear Energy (nuclear fission process; nuclear fuel; electricity production; nuclear reactor types; environmental advantages/disadvantages; safety issues; radiation and human health; radioactive wastes; nuclear fusion)
- E. Hydroelectric Power (dams; flood control; salmon; silting; other impacts)
- F. Energy Conservation (energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)
- G. Renewable Energy (solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

VI. Pollution

- A. Pollution Types
1. Air Pollution (sources — primary and secondary; major air pollutants; measurement units; smog; acid deposition — causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)
 2. Noise Pollution (sources; effects; control measures)
 3. Water Pollution (types; sources, causes, and effects; cultural eutrophication; groundwater pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)
 4. Solid Waste (types; disposal; reduction)
- B. Impacts on the Environment and Human Health
1. Hazards to Human Health (environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)
 2. Hazardous chemicals in the environment (types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)
- C. Economic Impacts (cost-benefit analysis; externalities; marginal costs; sustainability)

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VII. Global Change

- A. Stratospheric Ozone (formation of stratospheric ozone; ultraviolet radiation; causes of ozone depletion; effects of ozone depletion; strategies for reducing ozone depletion; relevant laws and treaties)
- B. Global Warming (greenhouse gases and the greenhouse effect; impacts and consequences of global warming; reducing climate change; relevant laws and treaties)
- C. Loss of Biodiversity
 1. Habitat loss; overuse; pollution; introduced species; endangered and extinct species
 2. Maintenance through conservation
 3. Relevant laws and treaties

Students who demonstrate understanding can:

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| HS-ETS1-1 | Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. |
| HS-ETS1-2 | Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. |
| HS-ETS1-3 | Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. |
| HS-ETS1-4 | Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. |

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The performance expectations were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

<h2 style="text-align: center; background-color: #4a7ebb; color: white; padding: 5px;">Science and Engineering Practices</h2>	<h2 style="text-align: center; background-color: #f4a460; color: white; padding: 5px;">Disciplinary Core Ideas</h2>	<h2 style="text-align: center; background-color: #90d1a0; color: white; padding: 5px;">Crosscutting Concepts</h2>
<p><u>Asking Questions and Defining Problems</u> Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.</p> <ul style="list-style-type: none"> Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) <p><u>Using Mathematics and Computational Thinking</u> Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</p> <ul style="list-style-type: none"> Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) <p><u>Constructing Explanations and Designing Solutions</u> Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.</p> <ul style="list-style-type: none"> Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3) 	<p><u>ETS1.A: Defining and Delimiting Engineering Problems</u></p> <ul style="list-style-type: none"> Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1) Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) <p><u>ETS1.B: Developing Possible Solutions</u></p> <ul style="list-style-type: none"> When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) <p><u>ETS1.C: Optimizing the Design Solution</u></p> <ul style="list-style-type: none"> Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2) 	<p><u>Systems and System Models</u></p> <ul style="list-style-type: none"> Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-ETS1-4) <p style="text-align: center;">-----</p> <p style="text-align: center;"><i>Connections to Engineering, Technology, and Applications of Science</i></p> <p><u>Influence of Science, Engineering, and Technology on Society and the Natural World</u></p> <ul style="list-style-type: none"> New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

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<p><i>Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include:</i> Physical Science: <u>HS-PS2-3</u>, <u>HS-PS3-3</u> <i>Connections to HS-ETS1.B: Developing Possible Solutions Problems include:</i> Earth and Space Science: <u>HS-ESS3-2</u>, <u>HS-ESS3-4</u> Life Science: <u>HS-LS2-7</u>, <u>HS-LS4-6</u> <i>Connections to MS-ETS1.C: Optimizing the Design Solution include:</i> Physical Science: <u>HS-PS1-6</u>, <u>HS-PS2-3</u></p>	
<p><i>Articulation of DCIs across grade-levels:</i> <u>MS.ETS1.A</u> (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4); <u>MS.ETS1.B</u> (HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4); <u>MS.ETS1.C</u> (HS-ETS1-2),(HS-ETS1-4)</p>	
<p><i>Common Core State Standards Connections:</i></p>	
<p><i>ELA/Literacy -</i></p>	
<u>RST.11-12.7</u>	<u>Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.</u> (HS-ETS1-1),(HS-ETS1-3)
<u>RST.11-12.8</u>	<u>Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.</u> (HS-ETS1-1),(HS-ETS1-3)
<u>RST.11-12.9</u>	<u>Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.</u> (HS-ETS1-1),(HS-ETS1-3)
<p><i>Mathematics -</i></p>	
<u>MP.2</u>	<u>Reason abstractly and quantitatively.</u> (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)
<u>MP.4</u>	<u>Model with mathematics.</u> (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

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