AP Environmental Science Syllabus: 2015-2016

Scoring Components		Page(s)
SC 1	The course provides instruction in Earth Systems.	3
SC 2	The course provides instruction in Earth Resources.	3, 4
SC 3	The course provides instruction in the Living World	4, 5
SC 4	The course provides instruction in Population.	5, 6
SC 5	The course provides instruction in Land Use.	6, 7, 8
SC 6	The course provides instruction in Water Use.	4
SC 7	The course provides instruction in Energy Resources.	8, 9
SC 8	The course provides instruction in Energy Consumption.	8
SC 9	The course provides instruction in Pollution.	3, 4, 8, 9
SC 10	The course provides instruction in Global Change.	9
SC 11	The course provides students with the scientific principles required to understand the interrelationships of the natural world and draws upon various scientific disciplines.	1
SC 12	The course includes methods for analyzing and interpreting information.	5, 6
SC 13	The course includes methods for analyzing and interpreting experimental data.	4, 5, 10
SC 14	The course includes methods for analyzing and interpreting mathematical calculations.	4, 5
SC 15	The course teaches students how to identify and analyze environmental problems.	6, 9
SC 16	The course teaches students how to critically examine various solutions for resolving or preventing environmental problems by evaluating the associated ecological and human health risks.	6, 9
SC 17	The course includes a laboratory and/or field investigation component. A minimum of one class period, or its equivalent, per week is spent engaged in laboratory and/or fieldwork.	2, 3

Course Description and Resources

Primary TEXT*:*
Living in the Environment, 17th edition by G. Tyler Miller and Scott E. Spoolman; Brooks/Cole Cengage Learning (AP edition), 2012

Supplemental TEXTS:
Environmental Science for AP, 2nd edition by Andrew Friedland and Rick Relyea; W.H. Freeman and Company, 2015

Additional RESOURCES:

1. Teachers Guide for AP Environmental Science for Miller's *Living in the Environment* (17th & 18th Editions)
2. College Board AP Environmental Science released exams (apcentral.collegeboard.com)
3. Introductory Concepts: Understanding Climate (College Board)
4. Lab Manual with Teacher Binder: Katheryn Weatherhead & Carol Matthew
5. Internet sources to include but not limited to:
    a. Nuclear Power Plant virtual 'field trip'
    b. Last Mountain – YouTube
    c. GIZMOS
6. Case Studies
    a. Science Listserv <SCIENCECASE-LIST@LISTSERV.BUFFALO.EDU> on behalf of NCCSTS help@SCIENCECASES.ORG
    b. Core case studies in *Living in the Environment,* Miller and Spoolman
7. Scientific journals and periodicals, including *Science Daily, Science News, Discover, and Scientific American*
8. Variety of DVD's and VHS Tapes to include, but not limited to *"The 11th Hour", "Flow", "Tapped", "Gas Land vs Fracknation", Planet Earth (biology **and** Earth Science editions), The People's Century "Endangered Planet", "Rachel Carson", "The Lorax" (original* Dr. Seuss version)
9. TASA software: Mapping concepts, Rocks, and Plate Tectonics

Course Overview:

AP environmental science is an interdisciplinary, multi-topic, lab-based college level course. The topics directly draw upon Biology, Chemistry, and Earth Science topics, along with Physics-based concepts. Quantitative analysis required for many calculations are algebra-based. The course provides students with skill set needed to collect, interpret, and analyze data; draw conclusions and formulate solutions to real-world environmental issues/problems. Calculating risk assessments of human and environmental health issues, understanding the interrelationships among biotic and abiotic components of the natural world, and the role humans play in altering the environment are among the topics emphasized in this course **[SC11].** The structure of the course is built on six themes:

- Science is a process
- Energy conversions underlie all ecological processes
- The Earth is one interconnected system
- Humans alter natural systems
- Environmental problems have a cultural and social context
- Human survival depends on developing practices that will achieve sustainable systems

SC11 the course provides students with the scientific principles required to understand the interrelation-ships of the natural world and draws upon various scientific disciplines

TOPIC OUTLINE

Major Topics in AP Environmental Science course and percentages represented on the AP Exam multiple choice section are as follows:

I. Earth Systems and Resources (10–15%)
   a. Earth Science Concepts; Atmosphere; Global Water; Soils
II. The Living World (10-15%)
   a. Ecosystem Structure; Energy Flow; Ecosystem Diversity; Natural Ecosystem Change; Natural Biogeochemical Cycles
III. Population (10-15%)
   a. Population and Biology concepts; Human population – dynamics, size, impacts of growth
IV. Land and Water Use (10-15%)
   a. Agriculture; Forestry; Rangelands; Mining; Fishing; Global Economics; Other uses – urban, transportation infrastructure, public and federal lands, land conservation, sustainable land-use
V. Energy Resources and Consumption (10-15%)
   a. Concepts, Consumption, Fossil Fuel Resources/Use; Nuclear Energy; Hydroelectric Power; Conservation; Renewable Energy
VI. Pollution (25-30%)
   a. Types – air, noise, water, solid waste; Environment and Human Health Impacts – hazards to humans, hazardous chemicals; Economic Impacts
VII. Global Change (10-15%)
   a. Stratospheric ozone; Global Warming (climate change); Loss of Biodiversity

LABORATORY AND FIELD STUDIES:

Laboratory and field study investigations are an integral part of AP Environmental Science. Students will be required to pass a laboratory/field safety quiz prior to participating in either type of activity. Formal laboratory reports and field notes, along with calculations (must show work) are required. Laboratory quizzes will also be administered. All data, observations, calculations, reports, and quizzes are to be kept in a separate laboratory notebook (preferably a 3-ring binder or purchased scientific lab notebook). All notebooks will be returned to the students as evidence for colleges requiring these materials for college credit. All lab and field investigations will be linked to major environmental concepts/topics **[SC17].**The expectation of the lab/field component is to ensure students' competencies in the following areas:

- Critically observe environmental systems
- Develop and conduct well-designed experiments
- Use appropriate techniques and instrumentation
- Collect, analyze, interpret, and communicate data, including statistical and graphical presentations
- Think analytically and apply concepts to the solution of environmental problems
- Make conclusions and evaluate their quality and validity
- Propose further questions for study (extensions of the original study)
- Communicate accurately and meaningfully about observations and conclusions, including correct use of units for measurements/calculations

CLASS FORMAT

AP Environmental Science classes meet 88 minutes every other day. Laboratory or field studies will be performed at least weekly, although mini-labs and demonstrations will be incorporated into lecture

materials and notes. Some field work will be required for homework (water and other sample collecting, nature journaling, on-going research). Instruction includes lectures, demonstrations, current events, and case studies discussions along with the laboratory and field work. There are opportunities for group projects, particularly with the energy unit and on-going environmental field work.

ASSESSMENTS:

Student mastery will be assessed based on results of tests/ unit tests, quizzes (lecture content and lab), formal lab write-ups, current events (local, state, national and global issues/topics), research projects, in-class assignments, and homework (classroom assignment completion, calculations, and research). First quarter, students will practice answering released Multiple Choice AP Environmental Science EXAM questions, and will learn how to successfully organize information to succinctly address free-response questions. Students will peer-review their classmates' free-response questions. Second quarter through third quarter, student responses to both multiple-choice and free-response questions will be included as graded assignments.

COURSE OUTLINE:

LABORATORY SAFETY ACTIVITY AND LAB QUIZ
INTRODUCTION TO ENVIRONMENTAL SCIENCE: Course content, protocols, expectations, materials
Planet Earth: Earth Science Concepts: Origin, composition, and components of Earth [**SC1, SC2, SC6]**

I. Earth Systems and Resources

SC1 the course provides instruction in Earth Systems

- **a.** Earth's 4 Spheres
- **b.** Biotic vs. Abiotic components
- **c.** Nebular hypothesis
  - **i.** Formation of the sun, planet Earth, Oceans and Atmosphere
    - **1.** YouTube video of Nebular Hypothesis
    - **2.** Lab activity: Atmospheric evolution and modern structure
  - ii. Atmosphere
    - *1.* Composition
    - *2.* Air Pollution **[SC9]**
      - *1.* Lab: Particulate pollution
      - *2.* Lichen Study – long-range study
    - *3.* Laws (Clean Air Act)
  - iii. Weather vs. Climate
    - *1.* Seasons and tilt of Earth – mini lab
    - *2.* Global Winds (Coriolis effect)
    - *3.* Ocean currents – warm vs. cold
      - *i.* El Niño/La Niña Activity

SC9 the course provides instruction in Pollution

SC17 the course includes a laboratory and/or filed investigation component. A minimum of one class block per week is engaged in laboratory and/or fieldwork

- d. Minerals, rocks, and the rock cycle
  - i. Mineral formation/groups
  - ii. Mineral resources
    1. Mining
       1. Extraction
       2. Global Reserves
          - i. Map Lab: All the World's Minerals
          - ii. Map Lab: Issues/pollution – Historical and Recent Spills/Contaminants **[SC9]**
       3. Laws/Treaties
    2. GIZMOS Lab: Rocks and Rock cycle

SC2 the course provides instruction in Earth Resources

e. Plate tectonics
    i. TAZA Software: Plate Tectonics: Advanced
        1. LAB: Plate boundaries and geologic locations/features (volcanoes)/events(earthquakes)
        2. Geologic hazards
f. Historical Geology
    i. Geologic Time
g. Weathering/Erosion & Soils
    i. Chemical and Mechanical processes
        1. Weathering & Erosion Field Study
    ii. Soil types
        1. Soils lab – using the soil texture triangle
        2. Soils lab – horizons/structure/abiotic and biotic components
    iii. Soil depletion/degradation and conservation – Best management practices
h. Culminating Activity: Lab 1A: Introduction to Environmental Problems: P x A x T = I
i. **Global Water Resources & Use [SC6]**
    i. All the Earth's water
        1. Location of Earth's fresh and salt water
        2. Surface vs Groundwater
            1. Groundwater flow demonstration
        3. Water quality (fresh)
            1. Water quality lab:
                i. Leaf-litter macroinvertebrate analysis and chemical tests (EPA water quality parameters)
                ii. Lab 13B: Freshwater Stream Water Quality Study
            2. Riparian Buffer Internet Activity
                i. Field Trip: Riparian buffer vs. non-buffered water: Chemical and Biological Measures of Stream Health
                ii. Save Our Streams Internet Water Quality Assessment Activity
        4. Water pollution **[SC9]**
            1. Sewage treatment and septic systems
                i. Field trip: Water and Sewage treatment facility
        5. Laws
j. Natural Biogeochemical Cycles – an overview
    i. Student research and report:
        1. Students will present one of the 5 biogeochemical cycles (conservation of matter will be presented in lecture). Student mastery will be assessed on inclusion of 5 major components of the presentation

II. The Living World – Ecosystems/Energy Flow/Cycles [SC3]

a. Energy Flow
    i. Conservation of Matter and Law of Thermodynamics **[SC11]**
    ii. Photosynthesis and respiration
        1. LAB: Measuring primary productivity in an aquatic ecosystem and effects of nutrient enrichment **[SC17]**
    iii. Food webs/chains and trophic levels
        1. Calculating energy loss through trophic levels
b. Ecosystem Structure

SC17 the course includes a laboratory and/or field investigation component.

SC17 the course includes a laboratory and/or filed investigation component. A minimum of one class block per week is engaged in laboratory and/or fieldwork

SC6 the course provides instruction in water use

SC13 the course includes methods for analyzing and interpreting experimental data

SC2 the course provides instruction in Earth Resources

SC3 the course provides instruction in the Living World

SC14 the course includes methods for analyzing and interpreting mathematical calculations

i. Populations and communities
    1. PopEcology Lab1
    2. Design Your Own Ecosystem Activity
ii. Ecological niches
iii. Species interaction and Keystone species
iv. Species diversity and edge effects
v. Biomes – aquatic and terrestrial
    1. World Biomes Mapping Activity
    2. Rust Sanctuary field study
        1. Comparison of field, pine, and hardwood forest communities

SC14 the course includes methods for analyzing and interpreting mathematical calculations

SC12 the course includes methods for analyzing and interpreting information

c. Ecosystem Diversity
    i. Natural Selection
        1. Bean Lab
        2. Resources and Survival Lab
    ii. Evolution
    iii. Ecosystem Services
d. Natural Ecosystem Change
    i. Climate shifts
        1. Map Lab: Historical/Current Climate
        2. Map Lab: Desertification
    ii. Species Movement
        1. Map Lab: Bird migration routes
    iii. Ecological succession
        1. Comparison of old-growth/new-growth forest (effects of logging and replanting)
        2. Primary vs. secondary succession: Forest fire vs. abandoned field
            1. Rust Sanctuary Field Study

SC17 the course includes a laboratory and/or filed investigation component. A minimum of one class block per week is engaged in laboratory and/or fieldwork

SC13 the course includes methods for analyzing and interpreting experimental data

III. **Population –Concepts/Human populations/Impacts [SC4]**
a. Population Biology Concepts
    i. Population ecology
        1. PopEcology Files: Graphing lab and survivorship curve analysis
        2. Lab 10: Elk and Vegetation Management Plan: Rocky Mountain National Park, Colorado
    ii. Carrying capacity
    iii. Reproductive strategies
    iv. Survivorship curves
b. Human Population
    i. Human population dynamics
        1. Historical population analysis
            1. Student-generated Time line: Human population correlated to industrial revolution and medical/technological advances
        2. Population distribution
        3. Fertility/growth rates and doubling time
            1. Calculating population growth – idealized and realistic equations
            2. Rule of 70
        4. Demographic transition and Age structure Diagrams

SC4 the course provides instruction in Population

SC13 the course includes methods for analyzing and interpreting experimental data

SC12 the course includes methods for analyzing and interpreting information

SC14 the course includes methods for analyzing and interpreting mathematical calculations

ii. Population Size
    1. Calculations
    2. Strategies for sustainability
    3. Case studies
    4. National policies
iii. Impacts of Human population growth
    1. Hunger
    2. Disease
        1. Mapping activity: Mapping movement/incident of disease
        2. Lab activity: Monoculture vs. biodiversity: Charting the progression of disease
    3. Economic effects
    4. Resource use
        1. Mapping activity: Global resources: Location vs use
    5. Habitat destruction
        1. Land Use Changes (Suburbanization/Urbanization, Transportation infrastructure and habitat/resource fragmentation/depletion and degradation map analysis and projected outcomes of future growth: Long-range study, predictions, and possible solutions
    6. Noise pollution **[SC9]**
        1. Effects
        2. Measures for control

SC12 the course includes methods for analyzing and interpreting information

SC15 the course teaches students how to identify and analyze environmental problems

SC16 the course teaches students how to critically examine various solutions for resolving or preventing environmental problems by evaluating the associated ecological and human health risks

IV. **Land Use [SC5]**

a. Agriculture
    i. Introductory activity: *"Tragedy of the Commons" – 'Goldfish' in a pond*
    ii. Food for a growing population
        1. Human nutritional requirements
        2. Types of agriculture
        3. Green Revolution
        4. Genetic engineering and crop production
            1. Debate: GMO foods and the environment
        5. Deforestation
        6. Irrigation
            1. Salinity
            2. Loss to evaporation: Lab activity
        7. Sustainable agriculture
            1. Agricultural practices: Comparison of Developed countries' and Underdeveloped countries' practices
            2. Mega-farms vs traditional farms: Comparison of practices
    iii. Pest control
        1. Chemical vs. biological vs. mechanical controls
            1. LAB: controlling fruit flies – chemical and organic options
        2. Costs and benefits of pesticide use
        3. Integrated pest control/management
        4. Laws

SC5 the course provides instruction in Land Use

SC15 the course teaches students how to identify and analyze environmental problems

b. Forestry
    i. Tree plantations

ii. Old-growth forests
iii. Forest fires
    1. Historical vs. current forest fires
iv. Forest management
    1. Presentation by Loudoun County Forester
    2. The Logging Debate – Should our National Forests be used by the logging industry?
v. National Forests
    1. Student research and presentation: US Forests

c. Rangelands (tied into long-range studies of habitat/resource fragmentation/depletion)

SC15 the course teaches students how to identify and analyze environmental problems

i. Overgrazing
    1. Calculating number of animals/acre: Cows, sheep, horses
        1. Soil compaction and permeability activity
ii. Deforestation
iii. Desertification
    1. Mapping lab: Encroaching deserts
iv. Rangeland management
    1. The Wolf/Predator Debate
v. Federal rangelands – role of the BLM

d. Other Land Use
i. Urban Land Use
    1. Planning an ideal community: Lab activity
    2. Suburban sprawl
        1. Presentation by Loudoun County Planning Commissioner
    3. Urbanization
        1. Mapping major urban areas and natural wildlife corridors
ii. Transportation infrastructure
    1. Federal Highway System
    2. Canals and channels
    3. Roadless areas
    4. Ecosystem impacts (tied to long-range study)
        1. Endangered and extinct species
iii. Public and Federal Lands
    1. Student reports on national parks and forests
    2. Wildlife Refuges – presentation by international veterinarian and Wildlife Rehabilitation Certified Veterinary Technician
    3. Wetlands
        1. Chesapeake Bay
            i. The Bay's report card
            ii. Mapping anoxic zones
            iii. Wetland soils analysis
        2. Laws: remediation/creation of wetlands

SC14 the course includes methods for analyzing and interpreting mathematical calculations

iv. Sustainable Land-use Strategies and Land Conservation (Preservation; remediation; mitigation; restoration)
    1. Imbedded content – wetlands, forests, prairie
        1. Vernal pools
        2. Student reports: US "report card" on natural lands/protected spaces

e. Fishing
    i. Techniques
    ii. Overfishing
        1. Endangered species
            1. *"What to avoid ordering/buying"*- comparison of populations of food fish in the last 50 years; Graphical and statistical analysis
    iii. Aquaculture
    iv. Laws (state/national/international)
f. Global Economics
    i. Globalization
    ii. World Bank
    iii. Laws/treaties

V. **Energy [SC8]**

a. Concepts and Consumption

SC8 the course provides instruction in Energy Consumption

i. Concepts
    1. Forms of Energy
    2. Power/Units/Conversions
    3. Brief review of Laws of Thermodynamics (ecosystems) **[SC11]**
ii. Consumption
    1. Historical perspective (Industrial revolution; exponential growth; energy crisis – tie into populations)
    2. Present global energy use and Future demands (tie-in to population growth)
    3. Comparison of cultures – developed vs. developing countries graphical analysis and projections

b. Energy Resources [SC7]

SC7 the course provides instruction in Energy Resources

i. Fossil Fuel Resources and Use
    1. Coal, petroleum, and Natural Gas (Hydraulic Fracturing)
        1. Production processes
        2. World reserves and global demand
            i. Map activity and analysis: Resources and geology
                1. Environmental advantages/disadvantages of sources
        3. Synthetic fuels
ii. Nuclear Energy
        1. Fission process/fuel
            i. Radioactive Decay Lab simulation
        2. Nuclear Reactors
            i. Types of reactors
            ii. Virtual Nuclear Plant tour and operation activity
        3. Advantages/Disadvantages
        4. Safety issues
            i. Radiation and human health **[SC9]**
            ii. **Waste [SC9]**
                1. Chernobyl – then and now
        5. Nuclear Fusion
iii. Hydroelectric power
    1. Dams

1. Student reports/presentation on the major dams of the world
2. Salmon and dams: impacts and strategies
3. Maintenance
    i. Silting
4. Environmental/Cultural impacts

iv. Renewable Energy
1. Student projects on Solar, hydrogen fuel cells, biomass, wind, small-scale hydroelectric, tidal and ocean wave-generated electricity, and geothermal
    1. Web search includes physical plant/construction/mechanics (electricity conversion), locations, environmental advantages and disadvantages
    2. Pizza Box Solar Oven Lab

v. Energy Conservation
1. Efficiencies
2. CAFÉ standards
3. Hybrid and electric vehicles
4. Mass transit

vi. Solid Waste [SC9]
1. Types, disposal, reduction
    1. Solid waste inventory

VI. Pollution's Impact on Human and Environmental Health [SC9]

a. Hazards to human health
    i. Environmental risk assessment/analysis; acute and chronic effects; dose-response relationships; indoor air pollutants; smoking and other risks
        1. The People's Choice: *Endangered Planet* video
            1. Student generated time-line of major disasters parallel to Environmental Laws/policies
            2. Calculating LD50

b. Hazardous Chemicals in the Environment
    i. Types/treatment/disposal of hazardous waste
    ii. Contamination clean up – include EPA superfund sites
        1. Hurricane Katrina
        2. Gulf spill
    iii. Biomagnification
        1. Rachel Carson's *Silent Spring* (Video)

c. Economic Impact
    i. Cost-benefit analysis
    ii. Externalities
    iii. Marginal costs
    iv. Sustainability
        1. "Design a Disaster" activity – students work in groups to create an environmental disaster. Group members role play – affected citizen, owner of the company/plant, Governor/Mayor of the town/city, environmentalist. Include economic/environmental impact, clean-up/remediation strategy, cost vs. benefit of clean-up/remediation, health impacts, time-frame. Presentation will include a "town council" format where findings are presented.**[SC16]**

SC16 the course teaches students how to critically examine various solutions for resolving or preventing environmental problems by evaluating associated ecological and human health risks

SC15 the course teaches students how to identify and analyze environmental problems

2. Gold King Mine disaster
    1. Assessment/predictions/solutions
    2. Alternate strategies for future clean-up

VII. Global Change [SC10]

SC10 the course provides instruction in Global Change

a. Stratospheric ozone
- **i.** Formation
    - **1.** Role of UV radiation
- **ii.** Depletion and effects of depletion
    - **1.** Strategies to reduce depletion
        - **1.** CFC's vs HCFC's
- **iii.** Laws/Treaties

SC13, 14 the course includes methods for analyzing and interpreting experimental data and mathematical calculations

SC12 the course includes methods for analyzing and interpreting information

b. Global Warming/Climate Change
- i. Greenhouse gases/Greenhouse Effect
    - **1.** An Inconvenient Truth excerpts
    - **2.** "How Big is a Pound Of CO_2" Activity/Calculations
- ii. Impacts/Consequences of Greenhouse Effect
    1. Bird Migratory routes
    2. The Monarch Butterflies in Mexico
- iii. Reducing Climate Change
- iv. Laws/Treaties

c. Loss of Biodiversity
- i. Habitat loss (loss vs. fragmentation)
    1. Overuse
    2. Pollution
    3. Introduced/Invasive species
        1. Snakehead fish Odyssey
        2. Lionfish
        3. Zebra Mussel
        4. Hydrilla and the Chesapeake bay
    4. Endangered and extinct species
        1. The Story of the Dodo
        2. Ivory Billed Woodpecker
        3. The Story of the Passenger Pigeon
        4. Excerpts from *The Sixth Extinction*
            - i. The Plight of the amphibians
- ii. Maintenance through conservation
- iii. Laws and Treaties

SC12 the course includes methods for analyzing and interpreting information