Fair Lawn

Public Schools

Fair Lawn, NJ

Advanced Placement Environmental Science

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Adopted 2000

Science Department

Fair Lawn School District

Committee Credits

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Advanced Placement Environmental Science

I. Course Synopsis

This is a college level course in environmental science with content and laboratories comparable to college work. The course will utilize a systems approach to follow the flow of matter and energy throughout the earth's biosphere and the earth's hydrologic, geologic, & atmospheric systems. Students will investigate how human impact causes alteration and disruption within the earth's systems. Special focus will be given to the use of technology including; remote sensing, geographic information systems, and global positioning systems as research tools to aid in the assessment of human impact on the systems of the earth. Students who achieve a grade on the AP exam which is acceptable to the college of their choice may receive college credit for this course. Students enrolling in this course should have strong motivation in the sciences and possess strong mathematical and verbal abilities.

Pre-requisites apply.

II. Philosophy & Rationale

The study of science can enable students to understand more completely the world around them and how they influence this world. This course will focus on building critical thinking skills and application of knowledge. Upon completion of this course, students will become aware of how discoveries and advances in environmental science are relevant to their lives.

III. Scope & Sequence

This is a working curriculum to be modified appropriately as needed throughout the 1999-2000 school year and completed by September 2000.

Unit 1: Matter, Forces, and Energy *(Sept)*

1. Atomic Structure
2. Atomic Bonding
3. The Periodic Table
4. States and Properties of Matter
5. Compounds
6. Elementary Physics
7. Measurement and Conversions
8. The Scientific Method
9. The Environmental Decision making process

Unit 2: Systems Modeling to Studying the Environment (Oct)

1. System vs. Surroundings
2. System Models
3. Implementing a System Model

Unit 3: Geographic Information Systems and Remote Sensing (Nov)

1. Geographic Information Systems (GIS)
2. Remote Sensing
3. Global Positioning Systems (GPS)

Unit 4: The Earth as a System (Dec)

1. Physical and Biogeochemical Processes
2. Organization and interactions within the Biosphere
3. Matter and Energy Flow through the Biosphere (sources and sinks)

Unit 5: Human Population Dynamics (Jan)

1. History of the Human Population
2. Human Demography
3. Nutritional Factors Controlling the Growth of the Human Population
4. The Theory of Demographic Transition
5. Artificial Methods of Controlling the Growth of the Human Population
6. The Future of Human Population Growth

Unit 6: Politics, Economics and the Environment (Feb)

1. Environmental Economics
2. Politics

Unit 7: Resources and Pollution (Mar)

1. Land and Land Use
2. Atmosphere
3. Hydrosphere
4. Wetlands
5. Energy

Unit 8: Environmental Health, Toxicology, and Human Exposure (Apr)

1. Environmental Health and Toxicology
2. Humans and Pesticides
3. Solid Waste, Toxic Waste and Hazardous Waste

Unit 9: Preservation, Restoration Ecology, and a Sustainable Future (May-Jun)

1. Ecosystem Management and Landscape Ecology
2. Preserving Nature
3. Sustainable Future

IV. Unit Descriptions

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1) **What is Environmental Science and Why do we study it?**

Unit 1: Matter, Forces, and Energy

(Elementary Chemistry and Physics)

1) **Atomic Structure**
   a) protons
   b) neutrons
   c) electrons
   d) isotopes
   e) ions (anions & cations)

2) **Atomic Bonding**
   a) electron shells (orbitals, clouds)
   b) electron configuration
   c) valence shell
   d) ionic bonds
   e) covalent bonds
   f) hydrogen bonds

3) **The Periodic Table**
   a) groups
   b) periods
   c) general characteristics

4) **States and Properties of Matter**
   a) solid
   b) liquids
   c) gasses

5) **Compounds**
   a) inorganic
   b) organic

6) **Elementary Physics**
- a) velocity ($v = \Delta d / \Delta t$)
- b) acceleration ($a = \Delta v / \Delta t$)
- c) gravity (a force due to gravity)(w=mg)(mass vs. weight)
- d) gravitational attraction ($F_g = GM_1M_2L_{-2}$)
- e) Newton's Laws
  - 1) Law 1
  - 2) Law 2 (F=ma)
  - 3) Law 3
- f) Kinetic Energy ($Ke = 1/2mv^2$)
- g) Potential Energy (Pe= mgh)
- h) Conservation of matter and energy
- i) First and Second Laws of Thermodynamics
- j) Electromagnetic Spectrum

7) **Measurement and Conversions**

8) **The Scientific Method**

9) **The Environmental Decision Making Process**

Unit 2: Systems Modeling Approaches to Studying the Environment

1) **System vs. Surroundings**
- a) What is a system?
- b) What are the surroundings?
- c) Entropy (the measure of disorder of a system)

2) **System Models** (transfer of mass and energy)
- a) Types of systems
  - $_1$) open systems
  - $_2$) closed systems
  - $_3$) isolated systems
- b) Self regulating systems and feedback mechanisms
  - $_1$) self-regulation
  - $_2$) feedback mechanisms
    - $_a$) negative-feedback
    - $_b$) positive-feedback

3**) Implementing a System Model**
- a) Black box

b) Grey box
c) White box

Unit 3: Geographic Information Systems and Remote Sensing

1) **Geographic Information Systems (GIS)**
   a) definition and components
   b) utilization of GIS to study environmental problems
   c) Arc View training

2) **Remote Sensing**
   a) definition and history
   b) utilization of remote sensing to study the earth
   c) ENVI training

Unit 4: The Earth as a System

1) **Physical and Biogeochemical Processes**
   a) Water cycle
   b) Biogeochemical processes
      1) Carbon cycle
      2) Nitrogen cycle
      3) Phosphorus cycle
      4) Sulfur cycle
   c) The lithosphere and plate motion
      1) plate tectonics
      2) geologic time
      3) earth history
      4) rock cycle
      5) soil formation
      6) geohazzards
         a) earthquakes
         b) volcanoes
         c) floods
         d) landslides

2) **Organization and interactions within the Biosphere**
   a) Cell structure

1) prokaryotic structure
2) eukaryotic structure

b) Tissues
c) Organs
d) Organism
e) Species
1) natural selection, adaptations, and evolution
2) niche
a) dimensions
b) tolerance limits (total dose response curve)
3) interactions
a) competition
b) commensalism
c) mutualism
d) predation
e) parasitism

f) Populations and Population Dynamics
1) types of growth curves
a) arithmetic
b) exponential (J curve)
c) S-curve
2) biotic potential
3) population isolations
4) chaotic and catastrophic population dynamics
5) Malthusian and Logistic growth patterns
6) factors influencing population change
a) natality, fecundity, and fertility
b) immigration and emigration
c) mortality and survivorship
d) population age structure
e) regulation of population growth
1) density-independent factors
2) density-dependant factors
a) interspecific interactions
b) intraspecific interactions
c) stress and overcrowding

g) Communities

1) food chains and webs
2) ecological diversity
3) ecological stability
4) ecological succession

h) Ecosystems
1) biotic factors
2) abiotic factors

i) Biomes
1) boundaries, transitions, and ecotones
2) biome types
a) terrestrial
1) desert
2) grasslands (prairies & savannas)
3) tundra
4) coniferous forest (taiga)
5) deciduous forest
6) rainforests (temperate & tropical)
7) polar
b) wetlands
c) aquatic
1) ocean (saline)
2) ponds (fresh)
3) streams (fresh)

h) The Biosphere and Biodiversity
1) What is biodiversity?
2) number, type, and distribution of species on earth
3) benefits of biologically diversity
4) threats to biodiversity
5) protecting biodiversity

3) **Matter and Energy Flow through the Biosphere (sources and sinks)**
a) Photosynthesis
b) Cell respiration
e) Food chains, Food webs, and Trophic levels
f) Productivity of Ecosystems

Unit 5: Human Population Dynamics

1) **History of the Human Population**
- a) origins of humans
- b) population growth (*Homo sapiens*)(last 10,000 years)

2) **Human Demography**
- a) global human population densities
- b) fertility and birth rates
- c) mortality and death rates
- d) population growth rates
- e) life span and life expectancy
- f) emigration and immigration
- g) factors contributing to birth rates

3) **Nutritional Factors Controlling the Growth of the Human Population**
- a) caloric intake requirements
- b) human nutrition
  - 1) proteins
  - 2) carbohydrates
  - 3) lipids and oils
  - 4) minerals
    - a) major minerals
    - b) trace minerals
  - 5) vitamins
- c) diet
- d) global food resource
  - 1) major crops
  - 2) meat and dairy products
  - 3) status of global croplands
  - 4) increasing food production
  - 5) green revolution
  - 6) new food sources
  - 7) blue revolution
- e) agricultural economics
  - 1) food surpluses and subsidies
  - 2) international food trade
- f) global food shortages
  - 1) famines
  - 2) chronic food shortages

3) what is the carrying capacity of the earth (food standpoint)

4) **The Theory of Demographic Transition**

5) **Artificial Methods of Controlling the Growth of the Human Population**

6) **The Future of Human Population Growth**

Unit 6: Politics, Economics and the Environment

1) Environmental Economics

a) economics and the environment
1) the "cost" of development
2) economic trade-offs
3) steady-state economics

b) economics, resources and reserves
1) types of resources
2) economic categories of resources and reserves
3) ownership of resources

c) economics, technology, population growth, and resource depletion
1) supply and demand vs. price
2) technology, the environment, and economics
3) population and economics
4) mitigating for resource scarcity
5) increasing the environmental carrying capacity

d) limits to economic and population growth

e) resource economics
1) internal and external costs
2) intergenerational justice and discount rates
3) cost/benefit ratios and analysis
4) distributing intangible resources
5) natural resource accounting
6) international development
7) international trade
8) jobs and the environment

f) sustainability

2) Politics

a) structure of government and how it effects the environmental laws
1) local government
2) state government

3) federal government

b) democrats vs. republicans vs. the environment

c) Environmental Protection Agency (EPA)

d) New Jersey Department of Environmental Protection and Energy (NJDEPE)

e) Local Planning Boards

Unit 7: Resources and Pollution

1) Land and Land Use

a) world land usage

b) soil and soil resources

1) soil structure and composition

2) soil types and uses (croplands and agriculture)

3) soil degradation

a) physical, chemical, biological degradation

b) erosion

4) agricultural resource other than soil

a) water

b) fertilizer

c) climate

d) energy

e) crop diversity

5) sustaining agriculture

a) soil conservation

b) low-input agriculture

c) public policy

6) agricultural pest control

a) what are pest and pesticides

b) history of pest control

c) types and uses of pesticides

d) benefits of pesticides

e) problems with pesticides

f) alternatives to current pesticide usage

c) mining and mineral resources

1) minerals and their uses

2) environmental impacts of mineral extraction

3) conservation of mineral resources

d) forests

1) types and distribution of forests

2) forest products
3) threats to forest
4) forest management and land ownership issues

e) rangelands
1) types and distribution of grasslands
2) grassland products
3) threats to grasslands
4) grassland management and land ownership issues

f) urbanization
1) what is urbanization?
2) what is a city?
3) global urbanization
4) urban, suburban and rural areas
5) suburban sprawl
6) factors contributing to urbanization
7) consequences of urbanization (urban crisis)
8) city planning and city design

2) Atmosphere

a) Structure, Composition, and Patterns of the Atmosphere
1) composition of the atmosphere
2) structure of the atmosphere
3) weather
a) solar radiation
b) convection currents
c) energy balance (use system approach)
c) Coriolis Effect
d) Hadley cells and global wind patterns
e) jet stream
f) fronts
g) cyclonic storms
h) seasonal wind patterns
4) climate
a) patterns of climatic cycles and oscillations

b) atmospheric pollution
1) sources and types of air pollutants
2) global and United States emissions of air pollutants

3) thermal inversions
4) effects of air pollution
5) controlling air pollution
6) air pollution legislation
7) climate change due to pollution
    a) greenhouse effect and global warming
    b) stratospheric ozone depletion
    c) sulfur emissions
    d) particulate emissions
8) current conditions and future prospects for air pollutants

c) indoor air quality
1) types, sources, and effects of common indoor air pollution
2) radon
3) asbestos
4) controlling indoor air pollution

3) Hydrosphere

a) water cycle
b) global distribution of water
c) constituents of water
1) fresh
2) saline
d) properties of water
1) cohesion
2) adhesion
3) surface tension
4) density

e) fresh water use
1) United States
    a) overall
    b) residential
2) Global use and availability (*ArcWorld*)
f) how does drinking water get to your house?
1) municipal water supplies
2) wells
g) wastewater
1) constituents of wastewater
2) municipal wastewater treatment
3) septic systems
h) motion and storage of water

1) fresh water
    a) surface
        1) lakes and ponds
            a) water budget
            b) nutrient sources
            c) trophic structure
            d) seasonal stratification
            e) eutrophication
        2) streams and rivers
            a) hydrographs
            b) velocity (equation and cross section of river)
            c) discharge
        3) overland runoff
            a) factors contributing to quantity of runoff
            b) estimating runoff (rational method)
    b) subsurface
        1) zones of subsurface water
        2) ordinary and artesian wells
        3) porosity of soils and strata
        4) groundwater velocity equations
2) ocean
    a) surface currents
    b) deep ocean currents
    c) tides
    d) trophic structure
    e) ocean pollution
    f) fishery distribution

i) sources of water pollutants
    1) point source vs. nonpoint source

j) types and effects of water pollutants
    1) biological (pathogens)
    2) chemical
        a) organic
        b) inorganic
    3) physical
    4) radioactive

k) state of water quality and quantity

l) methods of sampling and studying water
    1) stream surveys
    2) sampling methods

3) first and second order reaction kinetics
m) criteria in establishing water quality standards
n) methods of water conservation
o) water quality legislation
1) Clean Water Act of 1972
2) Marine Protection, Research, and Sanctuaries Act 1972 (amended 1988)
3) Safe Water Drinking Act of 1975
4) Comprehensive Environmental Response Compensation and Liability Act of 1980

4) **Wetlands**
a) what defines a wetland?
1) hydrology
2) soil
3) vegetation
b) wetland history
c) types and distribution of wetlands
d) wetland values
e) destruction of wetlands
f) current status of wetlands
g) changing the perception of wetlands
h) wetland protection and law

5) **Energy**
a) Global and United States Energy Production
b) Energy Consumption
c) Conventional Energy Sources
1) coal
a) sources/origin
b) uses/generation of electricity
c) advantages
d) disadvantages
2) oil
a) sources/origin
b) uses/generation of electricity
c) advantages
d) disadvantages
3) natural gas
a) sources/origin
b) uses/generation of electricity
c) advantages

d) disadvantages

4) nuclear fission
a) sources/origin
b) uses/generation of electricity
c) advantages
d) disadvantages

d) Conservation of Energy

e) Alternative Energy
a) solar
1) passive
2) active
3) solar cells
b) biomass
1) animal waste
2) fuel wood

c) hydroelectricity
a) uses/generation of electricity
b) advantages
c) disadvantages
d) wind
e) geothermal
f) tidal and wave energy
g) ocean thermal electric conversion
h) nuclear fusion

Unit 8: Environmental Health, Toxicology, and Human Exposure

1) **Environmental Health and Toxicology**

a) types of environmental health hazards
1) biological
a) viruses
b) bacteria
c) protozoa
d) fungi
2) chemical
a) organics

b) inorganics

3) physical

a) particulates

b) stress

c) noise

d) temperature

e) damaging regions of the electromagnetic spectrum

f) radioactivity

b) movement, distribution, and fate of toxins

1) solubility

2) vectors

3) degradability

4) biomagnification and bioaccumulation

c) factors controlling the toxicity of a substance

1) total dose response curve (dosage)

2) routes of exposure

3) exposure time

4) physical health (including immunological), stature, sex, maturity, etc.

5) ways in which the body minimizes toxicity

d) measuring toxicity

e) acute and chronic toxicity

f) public policy and risk assessment for human health (include MSDS)

2) **Humans and Pesticides**

a) human health problems associates with pesticides

b) reducing pesticide exposure

1) regulation of pesticide exposure

2) personal safety

3) **Solid Waste, Toxic Waste and Hazardous Waste**

a) solid waste

1) what is solid waste?

2) types and origins of solid wast

a) global solid waste

b) solid waste in the united states

1) overall

2) domestic solid waste

3) solid waste disposal

a) open dumps

b) ocean dumping
c) landfills (including remaining landfill space in US)
d) exporting waste
e) incineration
f) modern landfill design

4) solid waste reduction
a) recycling
b) composting
c) reusing
d) producing less waste
e) purchasing products with less packaging
f) manufacture of products that are degradable

b) hazardous and toxic waste
1) types of hazardous waste
2) hazardous waste disposal
a) incineration
b) surface lagoons
c) deep well injection
d) conversion to less hazardous substances
e) decrease production
f) on-site storage
g) permanent storage
h) secure landfills
3) hazardous materials legislation
a) The Resource Conservation and Recovery Act of 1976 (RCRA)
b) The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund Act)

Unit 9: Preservation, Restoration Ecology, and a Sustainable Future

1) **Ecosystem Management and Landscape Ecology**
a) methods of mitigation of disturbed ecosystems
1) restoration
2) remediation
3) rehabilitation
4) reclamation
5) re-creation
b) methods of ecosystem management

2) **Preserving Nature**

a) nature reserves and parks

1) history and origins
2) existing systems
3) problems with parks and reserves
4) future of nature reserves and public policy
5) conservation vs. economics and development
6) habitat fragmentation
7) nature preserve design and size requirements

b) wilderness areas

c) wildlife refugees

d) wetlands

3) **Sustainable Future**

a) sustainable future through environmental education

b) individual accountability and the environment

c) environmental groups and organizations

d) antienvironmentalism

e) international environmental organizations and legislation

f) green politics

g) United States environmental policies

1) national legislation, government structure, and the court system
2) environmental impact statements

V. Course Materials

"**Environmental Science A Global Concern**" by William P. Cunningham and Barbara Woodworth Saigo, 1997 edition (fourth edition)(Wm. C. Brown Publishers)(ISBN 0-697-28671-1).

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Students with special needs and ELL learners may be provided with key vocabulary terms prior to the unit beginning. In particular, the amount of key vocabulary terms should be reduced for ELL students.

2. ELL students may be provided with additional visual aids. For additional modifications, refer to Classroom Instruction that Works for ELL Learners *or the* SIOP protocol.
3. Gifted students may be challenged by asking them to form additional connections between biology, chemistry, and physics.

Cross Curricular Aspects

NJSLS Literacy: Click on the link to the High School Evidence Statements to see expectations related to literacy for this unit. In addition, a focus of the course will be on the development of the LAL standards for science & technical subjects.

NJSLS Math: Students will be expected to perform measurement, modeling, apply algebra, and geometry and statistics.

Interdisciplinary Connections and Alignment to Technology standards

Science classes in the Fair Lawn Public schools promote career-readiness skills related to Personal Financial Literacy (9.1) and Career Awareness, Exploration, and Presentation (9.2). Some course concepts from the Career and Technical Education Standards (9.3), but these are not directly correlated since our district is not a CTE program.

The Fair Lawn Public Schools District fosters an environment that promotes career-readiness skills in all content areas. Whereas Career Ready Practices are explored consistently, specific alignment to Personal Finance Literacy (9.1) and Career Awareness, Exploration, and Presentation Standards (9.2) are included in the district level document (below). When appropriate, the Career and Technical Education Standards (9.3) have been reviewed and aligned as well.

Examples: 9.2B: Career exploration in each unit of study.

In addition, every effort is made to integrate technology and engineering into our science classes. Educational Technology (8.1) and Technology Education, Engineering, Design, and Computational Thinking – Programming (8.2) standards are cross connected throughout our science programs.

Examples:
8.1A: Use spreadsheets to analyze & interpret data from laboratories, 6-12.
Use the internet to increase productivity and efficiency, 9-12.
8.1B,C: Use data to solve real-world problems, 6-12.
Use online platforms to collaborate & address global issues, 9-12.
8.1F: Collect and analyze data using internet and data simulations, 6-12.

8.2A: Become aware of the invention process, 3-5.
8.2B: Become aware of the global impacts on technology, 6-12.
8.2C: Apply the design process to pushes & pulls, K-2.
8.2D: Use tools to reduce work, K-2.

For additional detail on how these standards are integrated throughout the Fair Lawn Schools curriculum, review the Fair Lawn Public Schools District Alignment to Technology & Career Readiness & 21st Century Skills Standards Curriculum Appendix.