AP® Environmental Science
2005 Scoring Guidelines

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AP® ENVIRONMENTAL SCIENCE
2005 SCORING GUIDELINES

Question 1

Read the following article from the *Fremont Examiner*.

FREMONT EXAMINER

Diseases on the Rise!

Despite the fact that many old diseases have been effectively controlled by the use of antibiotics and vaccines, it appears that the world today is becoming more vulnerable to the outbreak of relatively new diseases such as severe acute respiratory syndrome (SARS) and West Nile Fever, and the reemergence and spread of old diseases such as malaria, cholera, and tuberculosis.

According to epidemiologist Dr. Amodie, "It is not possible to protect the health of Americans without addressing the problems of infectious diseases on a global scale."

The threat of the emergence and spread of newly arising infectious diseases has become a dangerous reality. These new diseases could become the endemic diseases of tomorrow.

(a) For one new disease <u>and</u> one old disease named in the article above, explain how the disease is transmitted through the human population and describe an effective method for controlling the spread of the disease.

(4 points possible)

For each disease, 1 point is earned for how the disease is transmitted to humans, and 1 point is earned for the method of controlling its spread.

<u>Note</u>: Students may receive a point for the method for controlling the spread of the disease without receiving the point for how the disease is transmitted.

HOW TRANSMITTED TO HUMANS	METHOD FOR CONTROLLING SPREAD OF DISEASE
SARS Transmitted directly from animals to humans	Not have animals and humans in close proximity Destroy infected animals
Virus spread by respiratory droplets (coughing, sneezing, mucus) of humans/close person-to-person contact	Quarantine infected individuals/stay at home Wear facial masks/cover mouth and nose Wash hands frequently
<u>Note</u>: Not sexually transmitted, blood borne, water borne, or transmitted by insect vectors	

Question 1 (continued)

West Nile Fever Transmitted by bite of infected mosquito	Reduce the mosquito population or the chance of being bitten. Must mention a specific method such as wearing more clothing/physical barriers, insect repellant, insecticides, eliminating standing water (e.g., tires, gutters), staying indoors in early evening, screening or mosquito netting, clearing vegetation around dwellings. Eradicate infected birds Use biological mosquito controls such as fish, frogs, bats, birds, Bacillus thuringiensis (Bt)
Transmitted by blood transfusions, organ transplants, and from mother to child during pregnancy	Screen blood donations, testing of pregnant women
Notes: Mosquitoes can be infected by biting an infected bird or horse. The disease cannot be transmitted from an infected human to an uninfected human via mosquitoes. Some public health advisories suggest direct transmission from birds/horses to humans.	
Malaria Transmitted by bite of infected mosquito	Reduce mosquito population or chance of being bitten (see scoring guidelines for **West Nile Fever**) Use biological mosquito controls (fish, frogs, bats, birds, Bt) Spray mosquito habitat with pesticides Take prophylactic antimalarial drugs
Transmitted by blood transfusions/organ transplants	Screen blood donations
Cholera Transmitted by ingestion of water/food contaminated with human fecal material (cholera bacteria)	Provide sanitary collection and treatment of sewage/black water Provide pathogen-free water supply Implement sanitary standards in food preparation Boil water to kill bacteria Shut down shellfish beds
Transmitted by inadequate hand washing (direct ingestion)	Increase practice of hand washing
Tuberculosis Bacterium spread by respiratory droplets (coughing, sneezing, mucus)	Immunization programs Quarantine Treatment of infected individuals with antibiotics

Question 1 (continued)

(b) For one of the two diseases you chose in part (a), identify one environmental factor that contributed to the emergence or reemergence of the disease and explain how that factor influenced the increased incidence of the disease.

(*2 points possible)*

One point is earned for the environmental factor, and 1 point is earned for how that factor influenced increased incidence.

Note: The factor and the explanation must be causally linked.

ENVIRONMENTAL FACTOR THAT CONTRIBUTED TO THE EMERGENCE OR REEMERGENCE OF THE DISEASE	HOW FACTOR INFLUENCED THE INCREASED INCIDENCE OF THE DISEASE
SARS High population density of humans Human contact with infected animals	Increased likelihood of transmission
West Nile Climate variability (El Niño, global climate change) Decrease in populations of mosquito predators Increase in mosquito habitat Environmental factors that increase availability of standing water	Led to increase of mosquito population Led to an increase in the likelihood of transmission
Increased transport of products and materials providing accidental transport of infected mosquitoes	Introduced the mosquito (vector) to new habitats
Malaria Decreased populations of mosquito predators Genetic resistance to pesticides	Increased mosquito population; increased transmission
Climate variability (El Niño, global climate change)	Increased mosquito habitat; increased transmission
Habitat alteration	Increased number of breeding sites for mosquitoes
Increasing human population density	Allowed for increased transmission opportunities
Emergence of microbes resistant to anti-malarial drugs	Led to increase in potential human host population

Question 1 (continued)

Cholera Lack of sanitation (transport/treatment) Lack of access to pathogen-free water	Increased transmission of pathogen
Increasing human population density Climate variability (El Niño, global climate change) Natural disasters (e.g., tsunamis, floods)	Conditions became suitable for outbreak (e.g., bacterial contamination increases, sanitation decreases)
Tuberculosis Increased human population density Evolution of strains of tuberculosis bacteria that are resistant to antibiotics	Increased opportunities for human-to-human transmission
Factors that increase susceptibility of human host (immune suppressed/compromised)	Decreased ability of immune system to destroy pathogen

(c) Provide a rationale to support Dr. Amodie's statement as quoted in the article.

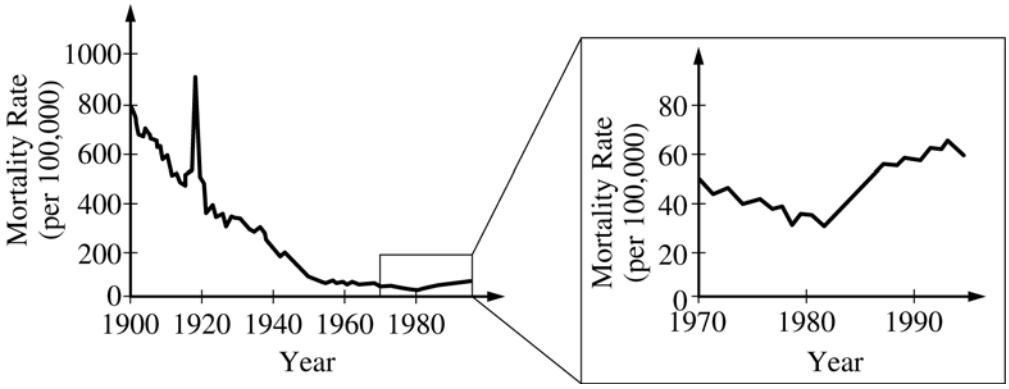
(2 points possible)

One point is earned for the mechanism, and 1 point is earned for an appropriate explanation that includes either a specific mode of transmission or protection (e.g., screening incoming travelers, isolation/containment of the disease locally). Other modes of transmission can be found in part (a).

MECHANISM	EXPLANATION
Increase in international travel/commerce Immigration from country to country Urbanization Ecosystem disturbance in previously uninhabited areas Deforestation in tropical regions Increased cultivation of rice Climate change High winds or hurricanes Accidental introduction of disease vectors Deliberate introduction of pathogens (bioterrorism) Flooding Natural migration of disease vectors Resistance to antibiotics or pesticides	Explanation must match mechanism.

Question 1 (continued)

INFECTIOUS DISEASE MORTALITY IN THE UNITED STATES, 1900–1996



(d) The graphs above show the mortality from infectious diseases in the United States since 1900. Identify an infectious disease that made an important contribution to the trend of increasing mortality rates that began in about 1980 and explain one major cause of the increased rate of mortality from that disease.

(2 points possible)

One point is earned for the disease, and 1 point is earned for the cause of the increased rate of mortality.

Disease: HIV/AIDS

Cause:
- infected blood transfusions/organ transplants
- sharing syringes
- having unprotected/unsafe sex and/or having multiple sex partners
- lack of education about how the disease is spread, leading to high risk behaviors
- transmission from mother to child
- lack of ability to develop effective treatments/vaccine/no permanent cure
- increased progression of disease in individuals/long incubation period
- opportunistic infections due to compromised immune systems

Disease: Influenza or pneumonia

Cause:
- increased mortality rate due to aging population
- drug-resistant strains of pneumonia

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Question 2

Between 1950 and 2000, global meat production increased from 52 billion kilograms to 240 billion kilograms. During this period, the global human population increased from 2.6 billion to 6.0 billion.

(a) Calculate the per capita meat production in 1950 and in 2000.

(2 points possible)

One point is earned for each year; each must include the proper set-up AND correct answer.

In 1950: $\frac{5.2 \times 10^{10} \text{ kg meat}}{2.6 \times 10^{9} \text{ people}} = 20 \text{ kg of meat per capita}$

In 2000: $\frac{2.4 \times 10^{11} \text{ kg meat}}{6.0 \times 10^{9} \text{ people}} = 40 \text{ kg of meat per capita}$

(b) Use the values from part (a) to calculate the change in global per capita meat production during this 50-year period as a percentage of the 1950 value.

(*2 points possible)*

One point is earned for proper set-up, and 1 point is earned for the correct answer.

$\frac{40 \text{ kg} - 20 \text{ kg}}{20 \text{ kg}} \times 100 = 100\%$ increase in global per capita meat production since 1950

OR

$\frac{40 \text{ kg}}{20 \text{ kg}} = 2.0$. This is a 100% increase.

OR

The 2000 value is 200% of the 1950 value.

Note: The answer must be given as a percentage. Students may earn the point for correctly calculating the percentage using incorrect values from part (a).

(c) Discuss why it is more efficient to produce grain for human consumption than to produce meat for human consumption. In your answer, consider both land use and energy use.

(2 points possible)

One point is earned for land use, and 1 point is earned for energy use.

Note: Students must clearly indicate a comparison between grain production and meat production.

LAND USE

When raising grain for human consumption, only land for grain growth is needed. If grain is used primarily for meat production, then land is needed for both growing grain and the raising of food animals (land for the housing, storage of feed and wastes, etc.).

A larger amount of rangeland is required for free-range livestock than for grain production.

In addition to grazing land, free-range livestock may require additional land to grow grain for fattening.

A hectare of land used for grain will feed more people than a hectare of land used for livestock.

ENERGY USE

Eating "lower on the food chain" is more efficient because energy is lost from transfer between trophic levels. A given amount of solar energy will sustain more people when it is consumed as grain than when that grain is fed to livestock to be consumed.

Less energy is required for the storage of grain than for the processing and storage of meat.

Compared to producing grain for direct consumption, more energy is required to
- produce grain to be fed to livestock (fertilizers, irrigation, pesticides, farm machinery, etc.);
- manage animal wastes (pumping, treatment, transport, disposal);
- take care of and round up free-range livestock.

(d) Describe TWO environmental consequences of the increase in the production of meat for human consumption.

(2 points possible)

One point is earned for each consequence.

Note: Students must correctly connect a problem with an environmental consequence. The list below includes the most common answers. A number of other correct problems could be described if linked to an appropriate environmental consequence.

Question 2 (continued)

PROBLEM	ENVIRONMENTAL CONSEQUENCE
Overgrazing or compaction of land	Desertification, increased erosion, nutrient loss
Pollution of waters from slaughter, animal wastes, grazing in riparian areas	Contamination of groundwater; increased BOD; increased turbidity; decreased DO; changes in temperature; eutrophication; fish kills; etc.
Land conversion (fencing, grassland conversion, deforestation)	Loss of habitat, habitat fragmentation, biodiversity loss, change in local precipitation patterns, increase in CO_2, desertification, erosion, nutrient loss.
Methane production from livestock	Contributes to climate change/global warming
Livestock production requires more water than grain production	Water depletion, water shortage

(e) Identify and explain one potential advantage and one potential disadvantage for human health of a diet that contains very little meat.

(2 points possible)

One point is earned for an advantage, and 1 point is earned for a disadvantage.

ADVANTAGES

Consuming less fat (or less red meat) reduces risk of:

- heart disease
- clogged arteries
- hypertension
- diabetes
- cancer
- elevated cholesterol

Reduced exposure to hormones, steroids, antibiotics, pesticides, PCBs, heavy metals

Reduced risk of developing diseases and infections such as: BSE (mad cow disease), *Salmonella*, *E. coli* infection, parasitic worms

DISADVANTAGES

Meat is a concentrated, excellent source of protein (it is difficult to get enough protein without meat).

Consuming very little meat could lead to some type of nutritional deficiency such as:

- Protein deficiency (kwashiorkor)
- Vitamin A deficiency (blindness)
- B-vitamin deficiency
- Iron deficiency (anemia)
- Trace element deficiency (e.g., Zn)
- Inadequate balance of essential fats

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Question 3

Most of the coal mined in the United States today comes from surface (strip) mines. In surface mining, the vegetation, soil, and rock covering the coal (referred to as overburden) are removed and set aside. After the coal has been hauled away, good conservation practices require that the overburden be replaced and the surface be restored to its original condition. Land restoration may be difficult in some regions, due to factors such as the local climate, the thickness of the coal seam, the extent of the overburden, and the sulfur content of the coal.

(a) Describe the steps that should be taken to restore the land after the overburden has been replaced.

(3 points possible)

One point is earned for each common step described, up to three.

ACCEPTABLE STEPS

- Recontouring/regrading land to its original topography
- Replacing and/or adding topsoil and/or nutrients as needed to improve soil quality or structure
- Replanting with native vegetation/fast growing species/early successional species
- Monitoring for either 5 or 10 years, depending on location

(b) Explain why the restoration of the land would likely be more difficult in an arid climate (one with less than 10 inches of precipitation per year).

(2 points possible)

For biotic or vegetation, 1 point is earned for indicating that it may be difficult to re-establish vegetation due to any of the following factors:

- low precipitation
- low fertility of soils in arid climates
- water-holding characteristics of soils in arid climates

For abiotic or consequence, 1 point is earned for indicating that as a consequence of the slow growth of vegetation the reclamation may be prolonged because of

- wind and/or water-related soil erosion
- runoff
- landslides

(c) Describe one environmental impact that the sulfur content of the remaining coal and the tailings would have on the reclamation process and suggest a possible remedy.

(2 points possible)

ACCEPTABLE ENVIRONMENTAL IMPACTS

One point is earned for correctly describing that sulfur in the coal and tailings may dissolve in water that percolates through them to form sulfuric acid (H_2SO_4) which results in

- acidification of the surrounding soil
- acidification of groundwater or adjacent bodies of water
- reduced plant growth/animal distribution
- corrosion of roads/drainage culverts
- increased solubility and transport of heavy metals

ACCEPTABLE REMEDIES

One point is earned for correctly identifying a remedy.

- Buffer/neutralize with alkaline/basic substances such as limestone (calcium carbonate, $CaCO_3$), sodium hydroxide (NaOH), sodium bicarbonate ($NaHCO_3$), and anhydrous ammonia (NH_3)
- Cover tailings to reduce contact with precipitation
- Sedimentation ponds/retention basins/catchments
- Bioremediation by sulfate-reducing bacteria

(d) Other than mining and reclamation, describe TWO environmental impacts of using coal for energy.

(2 points possible)

One point is earned for each of the first two acceptable impacts described.

ACCEPTABLE EMISSION-RELATED IMPACTS

- Wet acidic deposition (acid rain, acid precipitation) caused by sulfuric acid (H_2SO_4) or dry acidic deposition caused by oxides of nitrogen and/or sulfur (NO_x or SO_x) resulting from combustion
- Damage to/deterioration of ecosystems due to increased acidification as a result of acidic deposition
- Global climate change (global warming) as a result of the increased release of greenhouse gases (carbon dioxide, CO_2, methane, CH_4) from combustion into the atmosphere
- Industrial/photochemical smog as a result of the increased release of the byproducts of combustion
- Environmental pollution from radioactive materials (isotopes of uranium and thorium) released during combustion
- Fallout of heavy metals such as mercury (Hg) and arsenic (As) released during combustion
- Leaching of contaminates from sites where toxic ash resulting from combustion has been disposed
- Human respiratory illness caused by the increased release of particulates/byproducts of combustion
- Thermal pollution

ACCEPTABLE PROCESSING-RELATED IMPACTS

- Environmental degradation associated with the transportation of coal
- Environmental degradation associated with building coal-processing facilities
- Aesthetic degradation of the landscape as a result of the power plant or coal-processing facility

(e) Explain why per capita coal consumption in the United States is likely to increase.

(2 points possible)

One point is earned for connecting increased per capita demand for energy to an increased demand for coal because of its

- lower overall cost compared to other energy sources,
- higher availability in the U.S. than other fossil fuels, or
- suitability as an alternate source of energy necessitated by the reduction (real or projected) in the supply of other energy sources, such as oil.

One point is earned for connecting an increased per capita demand for energy due to increased affluence of the U.S. population.

Note: Simply stating that higher population will result in an increased demand for coal does not earn a point because it does not address the per capita demand.

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Question 4

The Alaskan National Wildlife Refuge (ANWR) on Alaska's North Slope is frequently in the news because petroleum geologists estimate that there are billions of barrels of economically recoverable oil beneath the surface of its frozen tundra. According to a 1998 United States Geological Survey (USGS) estimate, ANWR could contain up to 10 billion barrels of technically recoverable oil. Oil company officials advocate opening the refuge to oil exploration and the subsequent development of its petroleum resources. Environmentalists argue that oil exploration and development will damage this fragile ecosystem and urge Congress to protect ANWR by designating it as a wilderness area.

(a) The United States consumes approximately 20 million barrels of oil per day. According to the USGS estimate, for how many days would the technically recoverable oil resource in ANWR supply the total United States demand for oil?

(2 points possible)

One point is earned for a correct set-up, and 1 point is earned for the correct answer. Units are not required in calculations or in the answer.

$$\frac{10 \times 10^9 \text{ barrels}}{20 \times 10^6 \text{ barrels per day}} = 0.5 \times 10^3 \text{ days} = 500 \text{ days}$$

OR

$$\frac{10{,}000{,}000{,}000 \text{ barrels}}{20{,}000{,}000 \text{ barrels per day}} = 500 \text{ days}$$

(b) Describe TWO characteristics of arctic tundra that make it fragile and explain how these two characteristics make the tundra particularly susceptible to damage from human impacts.

(2 points possible)

One point is earned for each characteristic of arctic tundra linked to an appropriate susceptibility to damage.

CHARACTERISTICS	SUSCEPTIBILITY TO DAMAGE
Biological:	
Slow growth/decomposition rates	Slow recovery rates
Specialized species	Highly sensitive to environmental change
Simple food webs/low biodiversity	Minor alterations result in major changes
High biological concentrations	Isolated damage results in large effect on population
Climatological:	
Extremely cold conditions and very dry conditions	Slow growth and decomposition rates and slow rate of soil formation Low ability of tundra to flush pollutants
Short growing season	Slow recovery rates
Physical:	
Permafrost	Long residence time of accidental pollutants due to restricted vertical movement of fluids
Shallow, thin soils	Easily compacted/loss of integrity
Nutrient-poor soils	Slow recovery rates

Question 4 (continued)

(c) Identify TWO activities that would be associated with the development of ANWR petroleum resources and describe a substantial environmental impact of <u>each</u> in ANWR.

(4 points possible)

One point is earned for each different activity identified, and 1 point is earned for each impact correctly correlated to the identified activity. The impact may be the same for both activities identified.

ACTIVITIES

(1) Construction and use of drilling sites
(2) Construction and use of roadways
(3) Construction of airstrips
(4) Construction and use of housing facilities
(5) Construction of pipelines and/or storage facilities
(6) Increased air traffic
(7) Seismic surveying
(8) Waste disposal (residential waste and drilling waste)
(9) Construction of gravel mines

ENVIRONMENTAL IMPACTS

The identification of a general environmental effect (habitat loss, increased noise and light pollution, degradation of local air quality, decreased quantity and quality of surface water supplies, fragmentation of habitat, compaction of soils, etc.) derived from the identified activity is <u>not sufficient</u> for "description" of the impact. A full description must include the corresponding impact on biological systems. General terms such as "loss of biodiversity" or "death of animals" are <u>not acceptable</u> without relating them to a specific environmental impact shown below. In the list below, the activities that were accepted as correlating are indicated in parentheses after each impact.

Loss/reduction of breeding/calving/nesting areas (1, 2, 3, 4, 5, 6, 8, 9)

Loss/reduction of food resources (1, 2, 3, 4, 5, 6, 8, 9)

Loss/reduction of areas for shelters or dens (1, 2, 3, 4, 5, 6, 8, 9)

Displacement of populations (1, 2, 3, 4, 5, 6, 8, 9)

Disruption of migration routes (1, 2, 5, 6)

Decreased water resources for waterfowl and fish (2, 3)

Disruption of winter hibernation areas (7)

(d) Identify and describe TWO major end uses of the 20 million barrels of oil that the United States consumes each day, and for <u>each</u> use describe a conservation measure that would substantially reduce United States consumption.

(2 points possible)

One point is earned for each end use that is correlated to an appropriate conservation measure.

Question 4 (continued)

MAJOR END USES

(1) Petroleum fuel products—
  (a) transportation uses
  (b) heating uses
  (c) production of electricity
  (d) manufacturing processes
(2) Nonfuel products—solvents and lubricating oils, wax, asphalt
(3) Petrochemical industry—plastics, synthetic rubber, synthetic fibers, pesticides

CONSERVATION MEASURES

Note: Answers that would result in a substantial reduction in petroleum usage are acceptable. The identified conservation measure used must be correlated to a correct, previously identified major end use.

Reduction in use (1, 2, 3)

Drive less, improve efficiency, carpool, mass transit,

Turn down thermostat (heating), turn up thermostat (cooling), insulation

Less roadway building, less pesticide use, etc.

Educational programs designed to decrease use of energy

Economic incentives/disincentives designed to decrease use

Substitution of non-petroleum-based products (1, 2, 3)

Alternate energy sources (must identify source—coal, natural gas, solar, nuclear, etc.)

Use of synthetic lubricating oils

Use of glass, wood, etc., instead of plastics

Recycling/re-use of product (2, 3)

Recycling/re-use of lubricants, plastic products, etc.

Legislative action resulting in any of the above