

2002 AP[®] ENVIRONMENTAL SCIENCE FREE-RESPONSE QUESTIONS

ENVIRONMENTAL SCIENCE

SECTION II

Time—90 minutes

4 Questions

Directions: Answer all four questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers on the pages following the questions in this booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples.

1. Electric vehicles often have been proposed as an environmentally sound alternative to the gasoline engine for transportation. In response to state initiatives, several car manufacturers now include electric vehicles among their available models. In spite of these state initiatives, the penetration of electric vehicles into the transportation sector of the United States, as well as other countries, remains modest.
 - (a) Identify and describe two environmental benefits to using electric vehicles in place of gasoline-powered engines for transportation.
 - (b) Estimate the potential reduction in petroleum consumption (in gallons of gasoline per year) that could be achieved in the United States by introducing electric vehicles under the following assumptions:
 1. The mileage rate for the average car is 25 miles per gallon of gasoline.
 2. The average car is driven 10,000 miles per year.
 3. The United States has 150 million cars.
 4. 10 percent of United States cars could be replaced with electric vehicles.
 - (c) Some people have suggested that electric vehicles only shift the emission of air pollutants from dispersed sources to point sources. Explain and defend or refute this statement.
 - (d) Propose two potential new United States government policies that would encourage the widespread use of electric vehicles. Explain.
2. The Colorado River runs 1,450 miles from the headwaters of the Rocky Mountains to the Gulf of California. The river has many dams, aqueducts, and canals that divert water in order to supply water for electricity, irrigation, recreation, and domestic use.
 - (a) Describe and discuss two environmental problems that are associated with water diversion.
 - (b) If there is a shortage of water, choices will have to be made as to whether water should be diverted to urban areas, agricultural areas, or natural ecosystems. Make an argument for diverting water for urban consumption and an argument for permitting the flow of water to natural areas.
 - (c) Identify another example (other than the Colorado River) of a large-scale water-diversion project. Discuss two environmental problems that have resulted, or might result, from this project.

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Question 1

Total Score 10 Points

- (a) Identify and describe two environmental benefits to using electric vehicles in place of gasoline-powered engines for transportation. (4 points maximum)

The student can earn ONE point for identifying and ONE point for describing each environmental benefit. The description must be linked to the identified benefit. Only the first TWO environmental benefits cited are scored.

Identify (1 point)	Describe (1 point)
Decreased levels of:	
CO	improved human health (must cite specific, accurate, health impact of CO: reduced O ₂ transport, headaches, drowsiness, aggravates respiratory problems, coma, brain damage, death); no point for describing global warming due to CO
CO ₂	greenhouse gas therefore less global warming, decreased greenhouse effect, decreased acid precipitation (no point for just identifying CO ₂ as a greenhouse gas)
SO ₂	improved visibility, decreased acid precipitation, decreased property damage, improved human health (must cite specific, accurate, health impact of SO ₂ : aggravated respiratory problems)
NO _x	improved visibility, decreased acid precipitation, improved human health (must cite specific, accurate, health impact of NO _x : aggravated respiratory problems, increased susceptibility to respiratory infections)
VOCs/hydrocarbons	decreased secondary air pollutants (must cite specific example: PANs, O ₃), improved human health (must cite specific, accurate, impact of VOCs: decreased cancer rates, decreased lung irritation)
Particulates (SPM)	improved visibility, decreased property damage, improved human health (must cite specific, accurate, impact of SPMs: respiratory system irritation and damage, aggravated respiratory problems)
MTBE (from gas spills)	decreased groundwater contamination
Specifically identified secondary pollutant, PANs or O ₃	must give health/environmental benefit associated with a decrease in the specifically named secondary pollutant

NOTE: A decrease in lead emissions is NOT an acceptable identification for the United States, but IS an acceptable identification for a developing country or a country still using leaded gas. A specific health/environmental impact of decreased levels of atmospheric lead in that country would earn a description point.

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Question 1 (cont'd.)

Decreased use of petroleum leads to:	Results
Decreased release of toxins from refining	improved human health by decreased cancer rates, lung irritation, decreased ecosystem damage/disruption (must cite specific example)
Fewer oil spills, fewer pipeline leaks	less habitat destruction, decreased water contamination, decreased ecosystem damage/disruption (must cite specific example)
Fewer new oil wells, less extraction, fewer pipelines	less habitat destruction, decreased ecosystem damage/disruption (must cite specific example)
Fewer fluid leaks from gas cars	less surface and groundwater contamination (less oil on streets)
Less noise using electric vehicles	improved human health (must cite a specific problem such as hearing loss, less annoyance in high traffic areas), ecosystem disruption with specific example

NOTE: It is NOT ACCEPTABLE for a student to use generic terms for their answer such as the following: air pollution, smog, exhaust emissions, depletion of fossil fuels, non-renewable resource, carbon emissions, or sulfur emissions. A specific identification is required, as shown above, to earn credit.

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Question 1 (cont'd.)

- (b) Estimate the potential reduction in petroleum consumption (in gallons of gasoline per year) that could be achieved in the United States by introducing electric vehicles under the following assumptions:

The mileage rate for the average car is 25 miles per gallon of gasoline.

The average car is driven 10,000 miles per year.

The United States has 150 million cars.

10 percent of the United States cars could be replaced with electric vehicles.

(2 points maximum)

The student can earn ONE point for the correct setup (which must include units), and ONE point for the correct answer. The student is not penalized for failing to include (i) the unit ‘cars’ in their setup, OR (ii) the unit ‘gallons of gasoline per year’ in their answer, as these units are already stated in the question. The answer may be written in words and receive full credit.

$$(150 \text{ million cars}) \times (10,000 \text{ miles per year}) / 25 \text{ miles per gallon} \times 0.1 = 6 \text{ billion or } 6,000 \text{ million}$$

OR

$$(150 \times 10^6 \text{ cars}) \times (1 \times 10^4 \text{ miles per year}) / 25 \text{ miles per gallon} \times 0.1 = 6 \times 10^9$$

OR

$$(10,000 \text{ miles per year}) / 25 \text{ miles per gallon} = 400 \text{ gallons per year per car}$$

$$(150 \times 10^6 \text{ cars}) \times (.1) = 15 \times 10^6 \text{ cars}$$

$$(15 \times 10^6 \text{ cars}) \times (400 \text{ gallons per year per car}) = 6 \times 10^9 \text{ gallons saved}$$

OR

$$150 \text{ million cars} \times 10,000 \text{ miles per year} = 1,500,000,000,000 \text{ total miles per year}$$

$$(1,500,000,000,000 \text{ total miles per year}) / 25 \text{ miles per gallon} = 60,000,000,000 \text{ total gallons per year}$$

$$60,000,000,000 \text{ total gallons per year} \times 0.1 = 6,000,000,000 \text{ gallons saved}$$

OR

$$(10,000 \text{ miles per year}) / 25 \text{ miles per gallon} = 400 \text{ gallons per year per car}$$

$$400 \text{ gallons per year per car} \times 150 \text{ million cars} = 60,000,000,000 \text{ total gallons per year}$$

$$60,000,000,000 \text{ total gallons per year} \times 0.1 = 6,000,000,000 \text{ gallons saved}$$

OR

$$150 \text{ million cars} \times 0.9 = 135 \text{ million cars}$$

$$135 \text{ million cars} \times 10,000 \text{ miles per year} = 1,350,000,000,000 \text{ miles per year}$$

$$1,350,000,000,000 \text{ miles per year} / 25 \text{ miles per gallon} = 54,000,000,000 \text{ gallons used per year}$$

(with one of the above showing 150 million cars require a total of 60 billion gallons per year)

$$60 \text{ billion} - 54 \text{ billion} = 6 \text{ billion gallons saved}$$

OR

One of the above written in words.

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Question 1 (cont'd.)

- (c) Some people have suggested that electric vehicles only shift the emission of air pollutants from dispersed sources to point sources. Explain and defend or refute this statement. (2 points maximum)

The student can earn ONE point for an explanation and ONE point for EITHER defending OR refuting the statement. The student can receive a point for defending or refuting the statement without having to correctly explain the statement.

Explain (1 point): Gasoline cars must be identified as a dispersed (non-point, mobile) pollutant source, as opposed to electric cars, which obtain energy from an electrical generating power plant (point source, stationary source).

Defend (1 point): Electrical generating source identified as using combustion (oil, coal, natural gas, fossil fuels, biomass).

OR

Refute (1 point): Electrical generating source identified as solar, hydroelectric, nuclear, wind, fuel cells, or other non-combustion sources.

- (d) Propose two potential new United States government policies that would encourage the widespread use of electric vehicles. Explain. (2 points maximum)

The student can earn ONE point for each EXPLAINED new policy that would result in increased electric vehicle use. Only the first TWO policies cited are scored.

The proposal must include an action by the U.S. government and contain the mechanism for change. For example, increasing the cost of gasoline is not a direct function of the government, except by increasing gasoline taxes or by decreasing energy subsidies. The proposal must be linked to the way in which it would increase the use of electric vehicles.

Incentives for using electric cars:

- tax credits
- tax rebates for purchase of electric vehicle
- special travel lanes/no tolls/reduced tolls
- preferential parking
- supplies recharge stations
- investment in R & D (battery research, charging technology)
- mandated production/sales quotas for electric vehicles
- subsidies to companies that supply electric vehicles
- free electricity/reduced electric rate for owners of electric vehicles
- funding to education programs/advertising that promotes electric vehicles
- subsidized loans for the purchase of electric vehicles

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Question 1 (cont'd.)

Disincentives for gasoline vehicles (must explain how it increases use of electric vehicles)

- remove gas subsidies
- increase gas taxes
- increase gas-guzzler tax or surcharge
- emission penalties
- stricter emission standards
- higher fleet miles per gallon/higher CAFE standards
- rationing gas
- limit number of gas cars per family
- phase out/ban gas cars
- mandates production/sales limits for gasoline vehicles
- increase tariffs (taxes on imports) on petroleum
- boycott petroleum imports

NOTE: It is NOT acceptable for a student to simply suggest the following: raise the price of gas, increase or decrease insurance rates, impose full cost pricing (internalization of external costs), reduce price of electric vehicles.