



AP Environmental Science 2000 Student Samples

The materials included in these files are intended for non-commercial use by AP teachers for course and exam preparation; permission for any other use must be sought from the Advanced Placement Program. Teachers may reproduce them, in whole or in part, in limited quantities, for face-to-face teaching purposes but may not mass distribute the materials, electronically or otherwise. These materials and any copies made of them may not be resold, and the copyright notices must be retained as they appear here. This permission does not apply to any third-party copyrights contained herein.

These materials were produced by Educational Testing Service (ETS), which develops and administers the examinations of the Advanced Placement Program for the College Board. The College Board and Educational Testing Service (ETS) are dedicated to the principle of equal opportunity, and their programs, services, and employment policies are guided by that principle.

The College Board is a national nonprofit membership association dedicated to preparing, inspiring, and connecting students to college and opportunity. Founded in 1900, the association is composed of more than 3,900 schools, colleges, universities, and other educational organizations. Each year, the College Board serves over three million students and their parents, 22,000 high schools, and 3,500 colleges, through major programs and services in college admission, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT[®], the PSAT/NMSQT[™], the Advanced Placement Program[®] (AP[®]), and Pacesetter[®]. The College Board is committed to the principles of equity and excellence, and that commitment is embodied in all of its programs, services, activities, and concerns.

Copyright © 2001 by College Entrance Examination Board. All rights reserved. College Board, Advanced Placement Program, AP, and the acorn logo are registered trademarks of the College Entrance Examination Board.

1 Q1

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, NOT on the green insert. 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. A large, coal-fired electric power plant produces 12 million kilowatt-hours of electricity each day. Assume that an input of 10,000 BTU's of heat is required to produce an output of 1 kilowatt-hour of electricity.
 - (a) Showing all steps in your calculations, determine the number of
 - (i) BTU's of heat needed to generate the electricity produced by the power plant each day,
 - (ii) pounds of coal consumed by the power plant each day, assuming that one pound of coal yields 5,000 BTU's of heat,
 - (iii) pounds of sulfur released by the power plant each day, assuming that the coal contains one percent sulfur by weight.
 - (b) The Environmental Protection Agency (EPA) standard for power plants such as this one is that no more than 1.2 pounds of sulfur be emitted per million BTU's of heat generated. Using the results in part (a), determine whether the power plant meets the EPA standard.
 - (c) Describe two ways by which a fuel-burning electric power plant can reduce its sulfur emissions.
 - (d) Discuss why sulfur emissions from coal-fired power plants are considered an environmental problem and describe one negative effect on an ecosystem that has been associated with sulfur emissions.

a) (i) 12 million kwh/day
 10,000 BTU's = 1 kwh

12 million kwh x 10,000 BTU's = 120,000,000,000 BTU's needed to produce 12 million kwh of electricity each day

(ii) 1 lb coal = 5,000 BTU's
 Needed BTU's = 120,000,000,000; divided by 5,000 BTU's in one pound of coal will equal pounds of coal consumed
 $120,000,000,000 \text{ BTU's} \div 5,000 \text{ BTU's/pound} = 24,000,000 \text{ lbs}$

(iii) pounds of coal = 24,000,000
 multiply by 1% (.01) $24,000,000 \text{ lbs coal} \times .01 = 240,000 \text{ lbs sulfur}$

GO ON TO THE NEXT PAGE.

b.) There are 120,000,000,000 BTU's used each day
 The standard for sulfur = 1.2 lbs/million BTU's
 $120,000 \text{ million BTU's} \times 1.2 \text{ lbs of sulfur}$
 $= 144,000 \text{ lbs of sulfur is allowed by EPA.}$
 The plant uses 240,000 lbs of sulfur, so it
 is over the limit by 96,000 lbs of sulfur.

c.) A power plant can reduce its emissions by
 reducing the total amount of fuel (coal) that
 it burns. This fuel reduction may call for
 alternative fuel sources, such as nuclear or
 biomass.
 It can also use scrubbers in the smokestacks
 to reduce sulfur emissions. Scrubbers contain
 chemicals that are used to combine with
 the sulfur and form a precipitate. This
 sludge or precipitate will not be allowed to
 be emitted into the atmosphere. An example
 of a scrubber is a lime scrubber. It uses a
 lime spray to react with the sulfur to form a
 precipitate and reduce sulfur emissions into
 the atmosphere.

d.) When sulfur is released into the atmosphere it
 combines with water vapor and other chemicals
 to form acid precipitation. Acid rain that falls
 into an aquatic ecosystem changes the pH of
 the water. It causes a lower (or more acidic) pH.
 This change effects the amount of nutrients and
 minerals that the soil can hold. The H^+ ions won't

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

allow room for the heavy metals to connect to soil particles. This reduces the amount of nutrients that algae can absorb and decreases their population. A decrease in aquatic plants means less food and oxygen for aquatic animals. Acid rain, therefore, eventually leads to a decrease in biodiversity of aquatic ecosystems.

1 R 1

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, NOT on the green insert. 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. A large, coal-fired electric power plant produces 12 million kilowatt-hours of electricity each day. Assume that an input of 10,000 BTU's of heat is required to produce an output of 1 kilowatt-hour of electricity.

(a) Showing all steps in your calculations, determine the number of

(i) BTU's of heat needed to generate the electricity produced by the power plant each day,

(ii) pounds of coal consumed by the power plant each day, assuming that one pound of coal yields 5,000 BTU's of heat,

(iii) pounds of sulfur released by the power plant each day, assuming that the coal contains one percent sulfur by weight.

(b) The Environmental Protection Agency (EPA) standard for power plants such as this one is that no more than 1.2 pounds of sulfur be emitted per million BTU's of heat generated. Using the results in part (a), determine whether the power plant meets the EPA standard.

(c) Describe two ways by which a fuel-burning electric power plant can reduce its sulfur emissions.

(d) Discuss why sulfur emissions from coal-fired power plants are considered an environmental problem and describe one negative effect on an ecosystem that has been associated with sulfur emissions.

(a) (i) $12,000,000 \text{ kilowatt-hours} \times 10,000 \text{ BTU} = 120,000,000,000 \text{ BTU}$

(ii) $120,000,000,000 \text{ BTU} \div 5,000 \text{ BTU} = 24,000,000 \text{ pounds of coal}$

(iii) $24,000,000 \text{ pounds of coal} \times 1\% = 240,000 \text{ pounds of sulfur}$

(b) $\frac{240,000 \text{ pounds of sulfur}}{120,000,000,000 \text{ BTU}} = \frac{x}{1,000,000 \text{ BTU}}$ $x = 2 \text{ pounds of sulfur}$

This power plant does not meet the EPA standards because it emits 2 pounds of sulfur per million BTU's of heat generated.

(c) one way a fuel-burning electric power plant can reduce its sulfur emissions is to switch to a fuel source which contains less sulfur. This can also be a negative thing because the source with less sulfur might put out less

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

energy. The power plant might also use different techniques ~~sto~~, such as smoke stack scrubbers, chemical sprays that weigh down or neutralize pollutants, cyclones, which spin the waste pushing the pollutants against the side of the smoke stack, or electrostatic filters, which use electrical charges to trap ionic particles in smoke stacks, to reduce the amount of sulfur that is released from the plant.

(d) Sulfur emissions can cause ~~cause~~ environmental damage. The sulfur can get into a water supply making it undrinkable. It could also have a negative effect on the wildlife and agriculture of an area.

15.1

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, NOT on the green insert. 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. A large, coal-fired electric power plant produces 12 million kilowatt-hours of electricity each day. Assume that an input of 10,000 BTU's of heat is required to produce an output of 1 kilowatt-hour of electricity.
 - (a) Showing all steps in your calculations, determine the number of
 - (i) BTU's of heat needed to generate the electricity produced by the power plant each day,
 - (ii) pounds of coal consumed by the power plant each day, assuming that one pound of coal yields 5,000 BTU's of heat,
 - (iii) pounds of sulfur released by the power plant each day, assuming that the coal contains one percent sulfur by weight.
 - (b) The Environmental Protection Agency (EPA) standard for power plants such as this one is that no more than 1.2 pounds of sulfur be emitted per million BTU's of heat generated. Using the results in part (a), determine whether the power plant meets the EPA standard.
 - (c) Describe two ways by which a fuel-burning electric power plant can reduce its sulfur emissions.
 - (d) Discuss why sulfur emissions from coal-fired power plants are considered an environmental problem and describe one negative effect on an ecosystem that has been associated with sulfur emissions.

a) (i) we know that for every kilowatt-hour of electricity produced, 10,000 BTU's of heat are required. Therefore, if 12 million kilowatt-hours of electricity are produced, the total BTU's of heat will be $(10,000 \times 12,000,000)$. The total BTU's needed each day are 120,000,000,000 BTU's of heat.

(ii) To find the amount of coal needed, we divide the total BTU's of heat by 5,000. This equals 24,000,000 pounds of coal.

(iii) The total amount of sulfur released equals one percent of the total amount of coal.

GO ON TO THE NEXT PAGE.

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

One percent of 24,000,000 is 240,000 pounds of sulfur.

b) Since 18,000 BTU's of heat are generated, for every million BTU's of heat generated 120 pounds of sulfur are emitted. This greatly exceeds the amount allowed by the EPA. The plant does not meet the EPA standard.

c) A fuel burning plant can reduce its sulfur emissions by reducing the daily electricity output. This decreases the amount of coal needed which in turn will decrease the amount of sulfur released. A plant can also explore alternate sources of heat which do not cause harmful sulfur emissions.

d) When sulfur is released into the atmosphere, it bonds to form hydrosulfuric acid. Sulfur^{emissions} ~~is~~ ^{are} one of the main causes of acid rain. Acid rain is very harmful to the environment because it can lower the pH of lakes and disturb the ecosystem. Acid rain is also detrimental to crops.