

2001 AP[®] ENVIRONMENTAL SCIENCE FREE-RESPONSE QUESTIONS

3. In recent years, results from scientific studies have increased public awareness of the possible damage to human health from exposure to indoor air pollution.
- (a) Identify two specific indoor air pollutants and, for each, discuss the following.
- (i) The type of building most affected by the pollutant
 - (ii) Source(s) of the pollutant
 - (iii) The pollutant's effects on human health
 - (iv) The method(s) of prevention or cleanup of the pollutant
- (b) According to the Environmental Protection Agency, at least 17 percent of the four million commercial buildings in the United States can be considered "sick buildings."
- (i) Explain what is meant by the term "sick building."
 - (ii) Describe the criteria used for determining whether a building is "sick."

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

Question 3

3. (a) 10 points possible — 9 points maximum

2 points possible for identifying two indoor air pollutants: Students earn **1 point** for each specific indoor air pollutant identified *if* they have accurately discussed one or more of the items asked for in (i), (ii), (iii), or (iv).

0 points are earned for merely identifying one or two pollutants with no other information.

(i) 2 points possible

1 point for correctly identifying a building type appropriate for each pollutant identified. Type of building must be appropriately linked to source of pollutant.

For example:

“older buildings” for asbestos or lead

“newer buildings” for formaldehyde or VOC’s

“houses with wood-burning stoves” for carbon monoxide

(ii) 2 points possible

1 point each for correctly identifying a source for each pollutant identified (see chart).

If the source designated is exterior to the building, the respondent must provide an appropriate method of introducing the pollutant to the inside environment (see chart).

(iii) 2 points possible

1 point each for correctly identifying a human health effect for each pollutant identified (see chart).

(iv) 2 points possible

1 point each for correctly identifying a method of prevention or cleanup for each pollutant identified (see chart).

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

3. (b) 2 points maximum

(i) 1 point earned for an explanation of term “sick building” such as:

- “sick building” is a term which refers to a building in which a number of people report adverse health effects that they believe are related to the time they spend in the building
- “sick building” refers to a building in which air pollution brings about/causes a number of debilitating health effects
- “sick building” is a term used to describe a building in which occupants suffer persistent symptoms that disappear when they go outside
- “sick building” refers to a building which contains unhealthy levels of indoor air pollutants

(ii) 1 point for one of the following:

- When people report relief of symptoms (adverse health effects) when outside the building).
- When 20% or more of the occupants report some adverse health effect when inside the building.
- When occupants report any of the following symptom(s). Students must specify a minimum of two symptoms for one point.
 - Chronic respiratory problems/irritation of mucous membranes
 - Sinus infection
 - Sore throat
 - Irritability
 - Forgetfulness
 - Asthma
 - Shortness of breath
 - Hypersensitivity and Pneumonitis
 - Humidifier fever
 - Depression
 - Nerve disorders
 - Kidney/Liver damage
 - Ear infections
 - Reduced lung function
 - Onset of chest pain
 - Allergic reactions/responses
 - Muscle twitching/tingling sensation
 - Headaches
 - Rashes/skin irritation
 - Eye irritation
 - Impaired vision
- When a student indicates a method to determine the criteria listed above. For example, determining the levels of chemicals present or percentage of people with health effects.

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

Question 3 (cont.)

In the chart that follows on pages 12 through 19:

I.V. = Improved Ventilation

TSRM = Tobacco Smoke Reduction Methods — Stop smoking, smoke outdoors, legislative measures (banning, taxing, etc.)

Pollutant	Source(s)	Effect(s) on Health	Method(s) of Prevention or Clean-Up
Asbestos	Insulation, floor and ceiling tiles, spray-on fire retardant, roof shingles, millboard	Lung cancer, lung disease, mesothelioma, asbestosis, respiratory problems	Removal, encapsulation, appropriate legislative measures
Carbon Monoxide	Woodburning stove/ fireplace, tobacco smoke, motor vehicles, kerosene, natural gas, fuel oil appliances (must indicate a <u>combustion</u> source)	Headaches, drowsiness, irregular heartbeat, fatigue, impaired vision, dizziness, confusion, nausea, flu-like symptoms, reduced oxygen carrying capacity of RBC's, death	Improved ventilation, maintenance of appliances, alternate heating method (i.e., electric), stop smoking, appropriate legislative measures
Environmental Tobacco Smoke (ETS)	Cigarettes, cigars, pipe smoking, etc. Must be a combustion of tobacco	Cancer (lung, mouth, throat, bladder), respiratory problems, heart disease, emphysema, ear infections	Stop smoking, smoke outdoors, improved ventilation, appropriate legislative measures
Formaldehyde	Furniture stuffing, paneling, particle board, fiberboard, foam insulation, chipboard, ceiling tile, new furniture, plywood, carpeting	Irritation of eyes, nose, throat, skin, and lungs, nasal and lung cancer, nausea and dizziness, asthma, impaired breathing	Improved ventilation, alternative building materials, control of temperature and humidity environment, appropriate legislative measures

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

Question 3 (cont.)

Radon	Radioactive soil, rock foundations and building materials. Uranium deposits. Radioactive well water (must mention radioactivity or uranium in source)	Lung cancer or lung tissue damage as it relates to cancer effects (do not accept scarring or respiratory problems/irritant)	Improved ventilation, sealing cracks
Ammonia	Cleaning products	Respiratory irritant	Improved ventilation, alternate cleaning products, appropriate legislative measures
Arsenic	Smoking, pesticides, rodent poisons (rodenticides)	Toxic, carcinogen	Improved ventilation, stop smoking, alternative pest control, appropriate legislative measures
Bacteria	Air-handling systems, damp building materials, and furnishings	Bacterial diseases and infections (Legionnaires, strep, etc.)	Improved ventilation, humidity control, maintenance of filter systems, water treatment

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

Question 3 (cont.)

Benzene/Gasoline	Gasoline/gasoline powered equipment	See VOC's	Improved ventilation, alternate energy source
Benzo-α-Pyrene	Woodburning stove/fireplace, tobacco smoke	Lung cancer	Improved ventilation, stop smoking, proper maintenance of stove/fireplace, alternative heating source, appropriate legislative measures
Cadmium	Tobacco products, fungicides	Lung cancer and kidney damage	Improved ventilation, tobacco smoke reduction methods, appropriate legislative measures
Chloroform	Chlorine-treated water	Cancer	I.V., alternative disinfection methods
Carbon Dioxide	See carbon monoxide Also accept "people" (if building type is designated as overcrowded and poorly ventilated)	Oxygen deficiency problems — Headaches, drowsiness, irregular heartbeat, fatigue, impaired vision, dizziness, confusion, nausea	See carbon monoxide

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

Question 3 (cont.)

Methane/Propane	Leaking natural gas lines and appliances, leakage from underground tanks or landfills, anaerobic sewer backup	Oxygen deficiency problems — Headaches, drowsiness, irregular heartbeat, fatigue, impaired vision, dizziness, confusion, nausea	I.V., sealing of leaks, sealing foundations, maintenance of sewer lines/drains
Methylene Chloride	Paint strippers and thinners	Nervous disorders, diabetes	I.V., alternate strippers and thinners, appropriate legislative measures
Mold Spores	See Fungi	See Fungi	See Fungi
Moth Flakes/Balls (see Paradichlorobenzene)			
Nitrogen Dioxide	See Carbon Monoxide	Respiratory irritant, headaches	I.V., alternate heating sources, proper maintenance of appliances, Appropriate legislative measures
Ozone	Photocopiers, electrostatic air cleaners, outdoor air, electrical equipment	Respiratory irritant, fatigue, mucous membrane irritant, aggravates asthma and chronic bronchitis	I.V., legislation – to reduce NO _x and VOC's

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

Question 3 (cont.)

Paradichlorobenzene	Air fresheners, moth control products (moth flakes/balls)	Lung cancer, mucous membrane irritant	I.V., alternate products, appropriate legislative measures
Particulates	Tobacco combustion, outdoor air, trash incineration, wood burning, dust, factories, smelters, coal-burning power plant, kerosene heaters, agriculture, unpaved roads and construction, pet dander	Respiratory irritant, mucous membrane irritant, respiratory infections, bronchitis, lung cancer, asthma, lung damage, aggravates allergic reactions	Improved air filtration, alternative energy sources, TSRM, alternate heating sources, paving roads and dust control methods, alternative tilling practices, alternate trash disposal methods, grooming pets, appropriate legislative measures
Pesticides	Pesticides — sprays and strips and outdoor air	Possible carcinogen, mucous membrane irritant, central nervous system and kidney/liver damage	I.V., alternative pest control methods. <i>If source is outdoor air</i> — improved air filtration system.

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

Question 3 (cont.)

Carbon Tetrachloride	Solvent, paint stripper	See VOC's	I.V., alternate products
Fiberglass	Fiberboard products: awnings, tables, skateboards, tabletops, etc.	Potential carcinogen, respiratory irritant, skin irritant	I.V., alternate building materials, product maintenance
Fungi	Air-handling systems, damp building materials/furnishings	Respiratory irritant, aggravates asthma conditions, allergic reactions (watery eyes, sneezing, rashes, coughing)	I.V., humidity control, maintenance of air-handling systems
Lead Particulates (<u>must be airborne</u>)	Lead paint particulates (dust), smelters, contaminated soil, exhaust from leaded gasoline combustion.	Impaired mental and physical development, fatigue, headache, muscular tremor, clumsiness, loss of memory, convulsions, coma, high blood pressure, death, anemia, miscarriage/premature birth	I.V., alternate paints, indoor filtering systems, sealing of old paint, smelter filtering systems, alternative gasoline sources, appropriate legislative measures
Mercury	Fungicides, fossil fuel combustion, thermometers, thermostats	Damages nervous system, carcinogen	I.V., alternate fungicides, alternate energy sources, replacement of mercury-containing materials

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

Question 3 (cont.)

Pollen	Flowering plants	Allergic reactions, mucous membrane irritant, asthma	Improved air filtration, selective removal of problem plants
Styrene	Carpets, plastic products	Kidney and liver damage	Alternative flooring/plastic products, appropriate legislative measures
Sulfur Dioxide	Coal-burning power plants, coal and oil combustion, kerosene space heaters, outside air. If source is outside, must provide method of infiltration.	Restriction of airways, mucous membrane irritant, respiratory irritant, aggravation of asthma, emphysema, bronchitis	I.V., improved air filtration, alternate energy sources, low-sulfur coal, alternate heating sources, appropriate legislative measures
Trichloroethane	Aerosol sprays	Dizziness, irregular breathing	I.V., alternate products, appropriate legislative measures

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING GUIDELINES**

Question 3 (cont.)

Tetrachloroethylene	Dry cleaning fluid fumes	Nerve disorders, liver and kidney damage, possible cancer	I.V., alternate cleaning methods, appropriate legislative measures
Virus	Air handling systems, humans, outdoor air, animals	Viral diseases (colds, pneumonia, etc.)	Improved air filtration system, humidity control, sanitary health practices
Volatile Organic Compounds (VOC's)	Tobacco combustion, burned food products, paints, solvents, varnishes, cleaning products, carpets, building furnishings, draperies, clothing	Respiratory and mucous membrane irritant, weakened immune system, possible carcinogen.	I.V., TSRM, alternate products, air filtering system, appropriate legislative measures
Vinyl Chloride	Plastic plumbing, floor and wall coverings, countertops	Carcinogen	I.V., alternate products, appropriate legislative measures

3. In recent years, results from scientific studies have increased public awareness of the possible damage to human health from exposure to indoor air pollution.

(a) Identify two specific indoor air pollutants and, for each, discuss the following.

- (i) The type of building most affected by the pollutant
- (ii) Source(s) of the pollutant
- (iii) The pollutant's effects on human health
- (iv) The method(s) of prevention or cleanup of the pollutant

(b) According to the Environmental Protection Agency, at least 17 percent of the four million commercial buildings in the United States can be considered "sick buildings."

(i) Explain what is meant by the term "sick building."

(ii) Describe the criteria used for determining whether a building is "sick."

a) One major indoor air pollutant is cigarette smoke. Cigarette smoke is found in all buildings and travels ~~in the~~ through the air via vents and air circulation. Cigarette smoke comes from a point-source, cigarettes. Second hand smoke damages human lung tissue, ~~at~~ the cilia found in nasal pass and ~~throat~~ throat passages, and increases the likelihood of lung related diseases such as bronchitis and emphysema. It is a nasal and throat irritant, and makes people with chronic lung problems (asthma) more susceptible to other illnesses. Cigarette smoke can also decrease the effectiveness of the human immune system. The only prevention technique for cigarette smoke is for smokers to stop smoking or stop smoking in buildings. Designated "smoke areas" can be set up, where the second hand smoke will not disturb others.

another indoor air pollutant is asbestos. asbestos is found mainly in houses and business buildings it is a material found in the walls of buildings, and acts as an excellent insulator. However, it is very dangerous for human health because it flakes off walls and the tiny particles will become lodged ~~in~~ deeply in human lungs. asbestos can lead to the disease asbestosis. it irritates the lungs and can cause serious damage to lung tissue. new buildings are now not allowed to build with materials made with asbestos. however many old buildings have asbestos in their walls and air. The only way to check to see if a house contains asbestos is to have a company come and test, which can be rather expensive. once asbestos is identified, it is very expensive to remove.

b) ~~a "sick building" is one where the inhabitants/workers experience many~~ many modern buildings are termed "sick buildings" because ~~that~~ many of the building materials contain substances that ~~contribute~~ are unsafe and dangerous to the environment and/or

ADDITIONAL PAGE FOR ANSWERING QUESTION 3

human health. such things include ~~the~~ materials in air conditioners, vents, and walls. many people that work in "sick buildings" experience dizziness, nausea, headaches, and slowness due to the indoor air pollutants they are breathing in. If many of the individuals in ~~these~~ ~~but~~ buildings experience these symptoms, the building is termed "sick."

**AP[®] ENVIRONMENTAL SCIENCE
2001 SCORING COMMENTARY**

Question 3

Sample 3A (Score 10)

Part (a): 9 points were awarded in this part of the question. The student earned all 5 points available for their discussion of cigarette smoke: identification of a specific indoor air pollutant, with a discussion of the building type, source of the pollutant, human health effect, and a prevention/cleanup method. For asbestos, the student earned 4 points for the following: identifying asbestos, with a discussion of building type, a discussion of a source, and a discussion of a human health effect.

Part (b): 1 point was awarded for describing two (or more) symptoms that are commonly associated with sick buildings.

Sample 3B (Score 8)

Part (a): 7 points were awarded for part (a). The student earned all 5 points available for a discussion of cigarette/second-hand smoke; the student appropriately addressed each of the following: building, source, human health effects, and a prevention/cleanup method.

For asbestos, the student earned 2 points: 1 point for specifying asbestos with the second point coming from an appropriate human health effect.

In part (b), 1 point was earned for an accurate explanation of the term “sick building”.

Sample 3C (Score 7)

Part (a): 6 points were awarded in part (a). The student specified carbon monoxide as one pollutant, then accurately discussed a type of building, a source, and a human health effect. The student also earned 2 points for specifying radon as a pollutant, coupled with a discussion of a prevention/cleanup method.

Part (b): 1 point was earned for an appropriate explanation of the term “sick building”.

2001

Question 3

Standards

One point was awarded for each specific indoor air pollutant, if students accurately discussed one or more of the items asked for in (i), (ii), (iii), or (iv). No points were earned for merely identifying one or two pollutants, with no other information discussed. The point was awarded for

the first two pollutants discussed, with an internal maximum of 9 points on part (a). In (a) (i), the type of building discussed had to be appropriately linked to the source (a) (ii) of the pollutant specified. For example, “older buildings often contain asbestos in the form of a spray-on ceiling coating”. In (a) (iii), students were asked to discuss the pollutant’s effects on human health. In part (b) (i), 1 point was awarded for appropriately explaining what is meant by the term “sick building”; and 1 point was awarded in (b) (ii) for an accurate description of the criteria used for determining whether a building is “sick”.

Appropriateness of Student Preparation and Some Misconceptions

Overall, most students were able to identify at least one specific indoor air pollutant and to appropriately respond to one or more parts of the question. Some students confused the identification of the pollutant and the source of the pollutant. For example, some students identified “air fresheners” as a specific indoor air pollutant, when they should have discussed a pollutant such as para-dichlorobenzene as a specific indoor air pollutant that is contained in air fresheners.

Some students organized their response in an outline form, giving one, two, and three-word answers. Such responses lack sufficient discussion, explanation, and description. The directions for the free-response section of the exam clearly and specifically state **NOT** to address these questions in outline form. Students should respond in prose form, with answers as comprehensive as time permits.

What Teachers Can Do to Improve Performance

Teachers should give students practice in carefully reading questions and responding appropriately. When questions ask the student to describe, discuss, or explain, students should go beyond listing and identifying. Students who use outline form or one or two word answers do not demonstrate the depth of their knowledge.