AP® ENVIRONMENTAL SCIENCE
2010 SCORING GUIDELINES

Question 1

(a) Choose any ONE of the three pollutants mentioned above and respond to each of the following.

(i) Describe one specific source, other than the local chemical plants, for the toxic pollutant you chose.

One point can be earned for the description of a specific source of the pollutant. (Only the first answer is scored.)

PCBs	Mercury	Lead
• Transformers • Miscellaneous electronics • Hydraulic systems • Gas pipelines • Mining equipment • Lubricants • Pesticides • Wood treatments • Printing ink • Paint • Carbonless copy paper • Plastic • Waste oil • Roofing materials	• Coal burning • Gold mining • Thermometers • Barometers • Thermostats • Compact fluorescent lightbulbs • Switches • Appliances • Dental amalgam (fillings) • Use of Hg in cultural and religious practices • Batteries • Jewelry • Fungicides • Mine waste containing mercury	• Paint • Water pipes • Lead glaze on ceramics • Gasoline additives • Lead bullets and shot • Cosmetics • Jewelry • Traditional foods and medicines • Batteries • Electronics • Mine waste containing lead • Smelting

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Question 1 (continued)

(ii) Describe how the pollutant you chose enters the human body and one specific effect it can have on human health.

Two points can be earned: 1 point for describing how the pollutant enters the human body and 1 point for describing one human health effect of the pollutant.

How the pollutant enters the human body (Only the first answer is scored.)		
PCBs	**Mercury**	**Lead**
• Ingesting seafood contaminated with PCBs • Inhaling dust contaminated with PCBs • Absorption through skin • Drinking contaminated water	• Ingesting seafood contaminated with mercury • Ingesting food or water contaminated by soil, mine waste or particulates containing mercury • Inhaling mercury vapors (from broken thermometers, barometers, compact fluorescent lightbulbs, etc.) • Absorption through skin • Medical and dental procedures	• Ingesting food or water from ceramic tableware produced with lead-containing glazes • Ingesting food or water contaminated by soil, mine waste, particulates or plumbing containing lead • Ingesting lead-based paint • Inhaling dust or vapors contaminated with lead

Human health effects (Only the first answer is scored.)		
PCBs	**Mercury**	**Lead**
• Birth defects • Nervous system damage • Brain damage • Learning disabilities • Mental retardation • Paralysis • Attention deficit disorder • Damage to the reproductive system • Feminization • Low sperm counts • Hermaphroditism • Cancer	• Birth defects • Nervous system damage • Brain damage • Learning disabilities • Mental retardation • Paralysis • Attention deficit disorder • Reproductive system damage • Feminization • Low sperm counts • Hermaphroditism • Kidney damage • Hearing loss • Minamata disease • Autism* * While controversial, published studies have suggested a link between mercury and autism.	• Birth defects • Nervous system damage • Brain damage • Learning disabilities • Mental retardation • Paralysis • Attention deficit disorder • Kidney damage • Hearing loss • Anemia • Liver or stomach damage

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Question 1 (continued)

(iii) Describe TWO specific steps, other than an outright ban, that a city or nation can take to reduce the threat posed by this pollutant.

Two points can be earned: 1 point for each specific step that will reduce the threat posed by the pollutant. (Only the first two answers are scored.)

PCBs	Mercury	Lead
• Educate people about how to avoid PCBs	• Educate people about how to avoid mercury	• Educate people about how to avoid lead
• Substitute safer alternatives for PCBs	• Substitute safer alternatives for mercury	• Substitute safer alternatives for lead
• Replace products that contain PCBs with different products	• Replace products that contain mercury with different products	• Replace products that contain lead with different products
• Collect and safely dispose of products containing PCBs	• Collect and safely dispose of products containing mercury	• Collect and safely dispose of products containing lead
• Set and/or enforce policies that limit the production, use and discharge of PCBs	• Set and/or enforce policies that limit the extraction, production, use and discharge of mercury	• Set and/or enforce policies that limit the extraction, production, use and discharge of lead
• Phytoremediation of contaminated areas	• Phytoremediation of contaminated areas	• Phytoremediation of contaminated areas
• Treat water supplies to remove PCBs	• Treat water supplies to remove mercury	• Treat water supplies to remove lead
• Restrict fishing for species known to have high PCB concentrations	• Restrict fishing for species known to have high mercury concentrations	• Remove, cap or contain mine waste with high lead concentrations
• Dredge contaminated waterways	• Remove, cap or contain mine waste with high mercury concentrations	• Remove, cap or contain soils with high lead concentrations
• Wash contaminated soil	• Use technology to remove mercury from coal and smokestacks	• Remove lead-based paint from painted surfaces
• Incinerate contaminated soil	• Reduce coal burning	
	• Clean up mercury spills	

Question 1 (continued)

(b) Give one reason why Dr. Egguen is correct in asserting that children are particularly susceptible to toxic pollutants.

One point can be earned for a correct reason that children are particularly susceptible to toxic pollutants. (Only the first answer is scored.)

- Children take in more water, food and air per unit of body weight than adults.
- Children often put dirty objects or hands in their mouths.
- Children have less developed immune systems.
- The liver of a child does not metabolize pollutants as efficiently as the liver of an adult.
- The growing organ systems of children are more sensitive to pollutants than the mature systems of adults.
- Children will accumulate pollutants for a longer period of time than adults.

(c) An important contributor to global climate change is the release of CO_2 from the rapidly increasing number of coal-burning power plants in China. Assume that the coal burned at these plants to provide the power to manufacture a single MP3 player releases 40 kg of CO_2 and that it costs $0.75 to capture 1 kg of CO_2 and keep it from entering the atmosphere. Determine the cost, in dollars, to capture the total amount of CO_2 released from manufacturing one MP3 player.

Two points can be earned: 1 point for a correct setup and 1 point for the correct answer. (Units are not required.)

$$40 \ \cancel{\text{kg CO}_2} \times \frac{\$0.75}{1 \ \cancel{\text{kg CO}_2}} = \$30$$

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Question 1 (continued)

(d) Coal-burning power plants also release other pollutants, including nitrogen oxides (NO_x), sulfur oxides (SO_x), and particulates. Select one of these pollutants and identify one technology that can be used to remove it from the waste stream of coal-burning power plants.

One point can be earned for identifying a correct technology for the pollutant selected.

NO_x	SO_x	Particulates
• Coal gasification • Fluidized-bed combustion • Burning pulverized coal at reduced temperatures • Selective catalytic reduction	• Coal gasification • Fluidized-bed combustion • Scrubber • Removal of sulfur prior to burning coal	• Coal gasification • Fluidized-bed combustion • Scrubber • Filters • Baghouse filter • Electrostatic precipitator • Cyclone separator

(e) Discuss TWO reasons why a multinational company would choose to build a manufacturing facility in India and/or China rather than in the United States or Europe.

Two points can be earned: 1 point for each correct reason that is discussed. (Only the first two answers are scored.)

- Less stringent environmental regulations
- Lax enforcement of environmental regulations
- Less expensive labor
- Large populations of workers willing to work for lower wages
- Fewer workplace regulations
- Lower health-care costs for workers
- Less expensive property
- Less expensive raw materials
- Lower/fewer taxes and fees
- Government subsidies
- Lower litigation costs
- Expansion of markets

(c) An important contributor to global climate change is the release of CO_2 from the rapidly increasing number of coal-burning power plants in China. Assume that the coal burned at these plants to provide the power to manufacture a single MP3 player releases 40 kg of CO_2 and that it costs \$0.75 to capture 1 kg of CO_2 and keep it from entering the atmosphere. Determine the cost, in dollars, to capture the total amount of CO_2 released from manufacturing one MP3 player.

(d) Coal-burning power plants also release other pollutants, including nitrogen oxides (NO_x), sulfur oxides (SO_x), and particulates. Select one of these pollutants and identify one technology that can be used to remove it from the waste stream of coal-burning power plants.

(e) Discuss TWO reasons why a multinational company would choose to build a manufacturing facility in India and/or China rather than in the United States or Europe.

d) i) Lead can be found in lead based paints which were heavily used in the early 1400's for houses and other painting jobs, until lead was found to be harmful to the body. Can be found in Shot used for guns as well.
ii) Breathing in lead paint or shavings, drinking lead paint can cause lead poisoning which can cause kidney and liver damage. Being shot with lead ammo can also cause lead poisoning.
iii) Selling bird shot that doesn't have lead in it. Selling paint and other products that have a substitute for lead.

b) Children are more susceptible to pollutants because they haven't been exposed to the outside world long enough to have a decent immune system to ward toxins. Children are also more likely to put toxins in their mouths or to spill some on their skin. Their education level concerning toxins is slow so they don't have a complete understanding of the risks of toxins

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ADDITIONAL PAGE FOR ANSWERING QUESTION 1

c) So one mp3 is 40 kg of CO_2, cost per one kg of CO_2 is c. 75¢ So the amount (40 kg) of CO_2 needed multiplied by the price of each kg of CO_2 (.75¢) should equal the total ~~amount~~ price of one Mp3.

$40 \times .75 = 30.00\$$, 30.00$ is needed to capture the total amount of CO_2 necessary to make one mp3.

75
75
15
2000

d) Particulates can be removed from the smoke stacks of coal burning power plants by adding a wet scrubber to the smoke stack. A wet scrubber creates a fine mist that ~~particulates lower and~~ helps negate Particulates harmful effects in the atmosphere.

e) A multinational company would build in India or China vs. U.S.A or Europe because the price of labor is cheaper. One can get the same production ratio in China as the U.S at half the cost to pay employees

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(c) An important contributor to global climate change is the release of CO_2 from the rapidly increasing number of coal-burning power plants in China. Assume that the coal burned at these plants to provide the power to manufacture a single MP3 player releases 40 kg of CO_2 and that it costs \$0.75 to capture 1 kg of CO_2 and keep it from entering the atmosphere. Determine the cost, in dollars, to capture the total amount of CO_2 released from manufacturing one MP3 player.

(d) Coal-burning power plants also release other pollutants, including nitrogen oxides (NO_x), sulfur oxides (SO_x), and particulates. Select one of these pollutants and identify one technology that can be used to remove it from the waste stream of coal-burning power plants.

(e) Discuss TWO reasons why a multinational company would choose to build a manufacturing facility in India and/or China rather than in the United States or Europe.

a) (i) One specific source of lead is from paints, especially older paint which can be found in houses or on toys for kids.
(ii) Lead can enter the body by ingesting the pollutant by chipped paint when kids chew on the toys. One specific effect it can have is causing brain damage.
(iii) One step that can be pursued is to phase out the use of lead in the everyday materials we use, in addition, we can find substitutes for those materials so that the products are safer. A second step that can reduce the threat of lead is to offer rewards or incentives to help families replace products that may still contain lead, such as old pipes or kitchen ware

b) One reason that Dr. Egguen is correct in

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

asserting that children are ~~most~~ the most susceptible to toxic pollutants is because children are curious and they play in and eat dirt and ~~chew~~ chew on things that adults are less likely to. This allows for the children to be more susceptible to breathe in or ingest toxic pollutants such as PCBs, mercury and lead.

c) ~~40 kg of CO_2 per MP3 player~~ ~~$0.75~~ ~~capture 1 kg CO_2~~ ~~$30.00 the cost to~~

$\frac{40\text{ kg } CO_2 \text{ per MP3 player}}{\$0.75 \text{ capture } 1\text{ kg } CO_2}$

$\frac{40\text{kg}}{x} = \frac{\$0.75}{1\text{kg}}$

It would cost $27.25

0.75
3.00
0.00
4
0

d) ~~Sulfur oxides~~ Sulfur oxides can be removed from waste streams of coal-burning power plants by using wet-scrubbers that are used in smokestacks for these power plants to decrease toxic emissions.

e) One reason would be because there is less strict regulations in

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ADDITIONAL PAGE FOR ANSWERING QUESTION 1

India and ~~Europe~~ China which would allow these companies to get away with a lot more pollution. A second reason is because it is the most beneficial decision in terms of economy for these big industry companies. They do not have to pay as much in developing countries.

(c) An important contributor to global climate change is the release of CO_2 from the rapidly increasing number of coal-burning power plants in China. Assume that the coal burned at these plants to provide the power to manufacture a single MP3 player releases 40 kg of CO_2 and that it costs \$0.75 to capture 1 kg of CO_2 and keep it from entering the atmosphere. Determine the cost, in dollars, to capture the total amount of CO_2 released from manufacturing one MP3 player.

(d) Coal-burning power plants also release other pollutants, including nitrogen oxides (NO_x), sulfur oxides (SO_x), and particulates. Select one of these pollutants and identify one technology that can be used to remove it from the waste stream of coal-burning power plants.

(e) Discuss TWO reasons why a multinational company would choose to build a manufacturing facility in India and/or China rather than in the United States or Europe. Population

a) i.) I chose mercury and a source of mercury could come from solid waste. Mercury can be leached from items that contain the element and can be carried to sources of water.

ii.) Mercury can enter the body through unsafe drinking water in which a person has drunk out of already. Drinking water with mercury can damage the nervous system and certain parts of the brain.

iii.) Reduce or eliminate the use of products that contain mercury. Then for the existing mercury in bodies of water, use water treatment methods to reduce or eliminate the mercury content of the water.

b) She is correct in that assertion because there bodies haven't developed resistance. The children might accidentally drink from an unsafe drinking area and get poisoned due to the pollutant in that area of water.

c) $40 \text{ kg of } CO_2 \times \frac{\$0.75}{1 \text{ kg of } CO_2} = \boxed{\$30}$

$0.75
40
30.00

→

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d.) One technology that the power plants can use is a filter to remove particulates carried by the waste stream.

e.) One reason why a multinational company would choose China or India is because these two countries have the highest population in the world. More people will buy the company's products in those two countries rather than the U.S. or Europe, which have smaller populations. Another reason why would be resources. China, for instance, has the largest amount of coal reserves and the largest number of coal power plants, currently, thus more electricity will be provided for the company rather than U.S. or Europe

AP® ENVIRONMENTAL SCIENCE
2010 SCORING COMMENTARY

Question 1

Overview

This was a document-based question based on a mock newspaper article. The article reported on the effects of industrial pollution in an Indian town. Students were asked to describe a source, pathway into humans, human health effect and public measures for the control of PCBs, mercury or lead. In addition, students were asked to explain why children are more susceptible to toxic pollutants, to perform a calculation and to identify a type of technology that can reduce the amount of NO_x, SO_x or particulates from the waste stream of coal-burning power plants. Finally, students were asked to explain why a company would choose to build a manufacturing facility in China or India or both rather than in the United States or Europe.

Sample: 1A
Score: 10

Five points were earned in part (a). One point was earned in part (a)(i) for stating that paint is a source of lead. Two points were earned in part (a)(ii) for stating that "[b]reathing in lead paint" could explain how lead enters the body and for citing "liver damage" as one human health effect of lead. Two points were earned in part (a)(iii) for suggesting "[s]elling bird shot that doesn't have lead in it" and paint containing a substitute for lead.

One point was earned in part (b) for stating that children have a less developed immune system.

Two points were earned in part (c): 1 point for a correct setup and 1 point for the correct answer.

One point was earned in part (d) for stating that a scrubber can remove particulates from the smokestacks.

One point was earned in part (e) for stating that "the price of labor is cheaper" in India and China.

Sample: 1B
Score: 8

Five points were earned in part (a). One point was earned in part (a)(i) for stating that paints are a source of lead. Two points were earned in part (a)(ii): 1 point for stating that "ingesting … chipped paint" explains how lead enters the body and 1 point for stating that "brain damage" is a human health effect of lead exposure. Two points were earned in part (a)(iii) for stating that substitutes can be found to make products safer and for suggesting that "rewards or incentives" be used "to help families replace products that may still contain lead."

One point was earned in part (b) for stating that children "eat dirt and chew on things."

No points were earned in part (c).

One point was earned in part (d) for stating that scrubbers can remove sulfur oxides from the waste streams of coal-burning power plants.

One point was earned in part (e) for stating that there are fewer strict regulations in India and China.

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Question 1 (continued)

Sample: 1C
Score: 6

Two points were earned in part (a). No point was earned in part (a)(i). One point was earned in part (a)(ii) for stating that one human health effect of mercury is "damage" to "the nervous system." One point was earned in part (a)(iii) for stating that mercury pollution could be reduced or eliminated with "water treatment methods."

No points are earned in part (b).

Two points were earned in part (c): one point for a correct setup and 1 point for the correct answer.

One point was earned in part (d) for stating that "a filter" can "remove particulates."

One point was earned in part (e) for stating that "[m]ore people will buy the company's products in those two countries rather than the U.S. or Europe, which have smaller populations."