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 the pink 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. Read the following article from the *Fremont Gazette* and answer the questions that follow.

Fremont Gazette **Page 17**

Deadly Pollutants Kill Children in India and China

"Contaminated industrial sites in India and China top a new ranking of the world's most polluted places, where millions of people are threatened by various chemical pollutants," said Dr. Egguen, president of Fremont Friends of the Planet, an environmental advocacy organization. She said that the industrial town of Vapi, India, is a new addition to the list of worst-polluted places on Earth, based on the magnitude of the pollution and the number of people who are put at risk. She said, "Thousands of children, who are especially susceptible to toxic pollutants, are sick and dying in these top ten polluted places."

Dr. Egguen pointed out that mining and unregulated industrial production are the major culprits behind the menacing pollution. She described Vapi as a region overwhelmed by more than 50 chemical manufacturers that poison the local soils and groundwater with toxic pollutants such as PCBs, mercury, and lead. In fact, levels of heavy metals found in local produce are 60 times greater than those found in produce grown in unpolluted areas.

(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.

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

(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.

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

(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.

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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