The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

3. Respond to parts A, B, C, D, E, F, and G.

A. **Identify** a type of surface mining the company could use to access the coal.

B. **Describe** an environmental problem associated with surface mining.

C. The town is located downwind of the new coal-burning power plant.

Describe an environmental problem the town could experience as a result of the electricity generation at the coal-burning power plant.

D. The local government is concerned about the environmental consequences of using coal to generate electricity for the town.

Propose a realistic solution the local government could enact that would reduce the negative environmental consequences of using coal to generate electricity.

E. Burning one pound of coal produces an average of 0.88 kilowatt-hours (kWh) of electricity. An average household in the United States uses 1.064×10^4 kWh of electricity each year.

Calculate how many pounds of coal would need to be burned to generate enough electricity to power a town with 11,000 houses for a year. **Show** your work.

F. Researchers are concerned about the impact of noise pollution on songbirds in a forest near the power plant. Since the power plant was installed, bird species richness has declined from 7.5 species per hectare to 6.0 species per hectare.

Calculate the percent change in bird species per hectare since the power plant was installed. **Show** your work.

G. The town has been growing since it was built and had a growth rate of 5.38% in 2022, with a population of 26,250.

Assuming that the growth rate remains constant, **calculate** the year in which the population will reach 52,500. **Show** your work.

STOP

END OF EXAM

3. Crude oil is extracted, transported, and refined for various uses by humans.

(a) **Describe** one environmental impact on marine ecosystems associated with extraction or transportation of crude oil.

(b) **Identify** an atmospheric pollutant released during the combustion of refined oil products.

(c) **Propose** a solution an individual can use to reduce their reliance on refined oil products for transportation.

(d) **Justify** the solution proposed in part (c) by providing a benefit to human health.

Other natural resources, such as gold and silver, are also extracted. These resources can be used to make components for the electronics humans use. One metric ton of gold ore contains 5.0 grams of gold.

(e) A deposit is estimated to contain 260 million metric tons of gold ore. **Calculate** the number of grams of gold that could be extracted from the deposit. **Show** your work.

(f) Assuming the price of gold is $62.56 per gram, **calculate** the value of the gold that could be recovered from 1,000 metric tons of gold ore in the deposit. **Show** your work.

(g) A typical cell phone contains 0.034 grams of gold. **Calculate** how many metric tons of gold ore would need to be mined to extract enough gold to manufacture 100,000 cell phones. **Show** your work.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

STOP

END OF EXAM

ENVIRONMENTAL SCIENCE

SECTION II

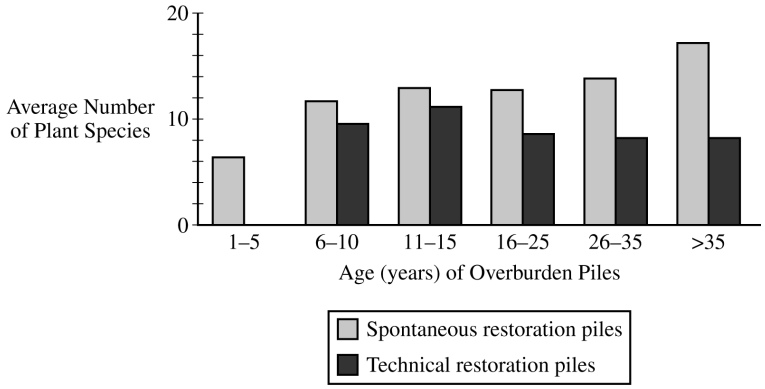
Time—1 hour and 10 minutes

3 Questions

Directions: Answer all three questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers in the Free Response 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. You may plan your answers in this orange booklet, but no credit will be given for anything written in this booklet. **You will only earn credit for what you write in the separate Free Response booklet.**

1. Two restoration methods designed to reclaim the overburden piles removed from open pit coal mines in temperate forests of eastern Europe were studied over several years. The first method was spontaneous restoration, where the soil and rock were dumped in noncompacted, random piles and not replanted with vegetation. The second method was technical restoration, where the land was leveled by heavy machinery, organic material was added, and eight plant species were added. Technical restoration started 5 years after the piles were formed, so no bar is included in the 1–5 year range in the graph.

Number of Plant Species in Spontaneous and Technically Restored Overburden Piles over Time



(a) Based on the data in the graph, **identify** the average number of species found in technically restored piles 16–25 years after restoration started.

(b) Based on the data in the graph, **describe** the relationship between the average number of species and the age of the spontaneous restoration piles.

Scientists hypothesized that after 35 years, the number of animal species in the spontaneously restored piles would be higher than the number of animal species in the technically restored piles.

(c) Using the data in the graph, **make a claim** that supports or refutes the hypothesis that the number of animal species in the spontaneously restored piles would be higher than the number of animal species in the technically restored piles.

(d) **Describe** a characteristic of a plant species that would have been present in the spontaneous restoration piles from years 1 to 5.

(e) **Explain** how the return of plant life would have been altered in the spontaneous piles if the mining had taken place in the tundra rather than in temperate forests.

Limiting runoff on disturbed land improves soil and water quality. To model water runoff, students set up three large plastic trays and filled each tray with loam soil to 1 centimeter below the edge. Loam soil is a balance of sand, silt, and clay soil. One tray was seeded with wheatgrass and grown for 30 days, one tray was covered with small wood chips, and one tray was soil only. Five hundred milliliters of water was sprinkled evenly onto the soil surface of each tray. All three trays were placed on a slight slope, and water that ran off the surface was collected. The results are shown in the following table.

Tray	Water Collected (mL)	Water Appearance
Wheatgrass grown in soil; no small wood chips	190	Clear
Small wood chips covered soil; no wheatgrass	300	Transparent; light brown
Soil only; no wheatgrass or small wood chips	360	Cloudy; dark brown

(f) **Identify** the scientific question for the investigation.

(g) **Identify** a dependent variable in the experiment.

(h) **Explain** how the results of the experiment would likely have been altered if the soil had contained a higher percentage of sand, which has the largest particle size of the components of loam.

Runoff from mining waste can also affect water quality.

(i) **Describe** one ecological impact that could result from the drainage from mine waste into nearby waterways.

(j) **Describe** one strategy to reduce the drainage from mine waste into waterways downstream from mines.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

2. Iron ores are rocks from which metallic iron can be extracted for steel production. This process involves several steps. Iron ore is first mined and then turned into pig iron in a blast furnace, and some rock waste such as silicon dioxide is separated out. In the final step, the pig iron is refined into steel using a process that includes reacting the molten pig iron with oxygen to remove impurities.

   (a) Use the data below to respond to the following. For each calculation, show all your work.

Global Iron and Steel Data
1.6 billion tons of iron ore are used yearly to make pig iron.
1.2 billion tons of pig iron are produced each year.
Iron ore reserves are estimated to be 800 billion tons.
95% of iron ore that is mined is used in steel production.

   (i) **Calculate** the weight (in tons) of rock waste produced globally each year when iron ore is converted to pig iron.

   (ii) **Calculate** the weight (in tons) of pig iron that could be produced if all of the estimated global iron ore reserves were used for pig iron production.

   (iii) **Calculate** the weight (in tons) of the current global iron ore reserves that would be used to make steel if the current trends continue.

   Both iron ore and coal are mined for use in the manufacture of steel. It is estimated that for every ton of steel recycled, 1.25 fewer tons of iron ore and 0.7 fewer tons of coal must be mined. About 80 million tons of steel are recycled each year in North America.

   (b) **Calculate** the weight (in tons) of coal that is conserved each year in North America by recycling steel.

   Before the year 1900, most mining companies abandoned surface and subsurface coal mine sites once the resource was depleted.

   (c) **Describe** TWO environmental problems that are associated with abandoned coal mine sites.

   (d) **Describe** one method that can be used to mitigate one of the problems you identified in part (c).

   (e) **Discuss** one reason why surface coal mining is generally less expensive than subsurface mining.