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.

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**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**





3. North Carolina is one of the fastest-growing states by population in the United States, with most growth concentrated in major cities like Charlotte. Increased population leads to increased demands for resources such as power and water.

The majority of electrical energy in North Carolina is produced during the combustion of coal.

(a) **Identify** one negative human health effect linked to the exposure to pollutants resulting from the combustion of coal.

(b) Coal ash, the powdery, solid substance that remains after coal combustion, presents a variety of potential environmental issues. Disposal of toxic coal ash is a growing concern in the state. Coal ash can be mixed with water and disposed of in large, unlined pits or as dry ash in landfills.

(i) **Describe** an environmental problem associated with coal ash waste disposal.
(ii) A proposed solution is to dispose of North Carolina's coal ash in clay-lined pits. **Justify** this solution by providing one advantage of using clay soil.

(c) The population of Charlotte, North Carolina, has grown over the last few decades. The table shows the increase in the population size of Charlotte from 2013 to 2019.

**Population of Charlotte, North Carolina, 2013–2019**

| Year | Population |
|---|---|
| 2013 | 757,278 |
| 2014 | 774,807 |
| 2015 | 792,137 |
| 2016 | 808,834 |
| 2017 | 826,060 |
| 2018 | 841,611 |
| 2019 | 857,425 |

(i) **Calculate** the percent change in Charlotte's population from 2013 to 2019. **Show** your work.
(ii) Based on Charlotte's 2019 growth rate of 1.88%, **calculate** the year when the population of Charlotte will double, assuming the growth rate stays the same. **Show** your work.
(iii) The average Charlotte resident uses 90 gallons of water per day. **Calculate** the gallons of water used by the population of Charlotte in the year 2018. **Show** your work.

(d) Drought periods are becoming more frequent in North Carolina, causing water resources to become more scarce. **Describe** one realistic action that citizens could take to reduce domestic outdoor water use.

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**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**

2. Pesticides have been utilized for many years to increase food production and control pest populations. Pesticide use can be both beneficial and harmful to humans and other organisms.

(a) Pesticide use has advantages, disadvantages, and unintended consequences on human health. **Describe** one benefit to human health that can result from the use of pesticides.

(b) **Identify** one way chemical pesticides can enter the human body.

Cotton farmers in the southern United States used a chemical pesticide to control an insect cotton-crop pest over a 40-year period. To study the effectiveness of the pesticide as an insect pest-control strategy, traps were placed in treated cotton fields and the number of pests captured were compared to application rates for the pesticide. The results of the study are shown in the table below.

| Year | Grams of Pesticide Applied per Hectare | Number of Crop Insect Pests Captured |
|---|---|---|
| 1960 | 0 | 700 |
| 1975 | 500 | 2 |
| 1980 | 500 | 3 |
| 1985 | 500 | 8 |
| 1990 | 550 | 14 |
| 1995 | 600 | 83 |
| 2000 | 700 | 150 |
| 2005 | 800 | 405 |
| 2010 | 900 | 727 |
| 2015 | 1,000 | 1,100 |

(c) Use the data in the table to answer the following questions.

(i) **Identify** the year when the pesticide was most effective at reducing the size of the pest population.

(ii) **Describe** the change in the number of crop insect pests in the cotton fields over time.

(iii) **Explain** how the change in the cotton-crop pesticide effectiveness between the initial application in 1975 and the latest application in 2015 illustrates genetic resistance in pests, based on the data in the table.

(d) **Describe** TWO effects of pesticide use, other than death, on nontarget wildlife.





(e) There are many problems associated with the repeated application of chemical pesticides to reduce pest populations.

(i) Crop rotation is often used to reduce pesticide use. **Describe** the process of crop rotation.

(ii) **Propose** one reasonable method, other than crop rotation, of reducing the use of pesticides in agricultural practices while still maintaining a high crop yield.

(iii) **Justify** how the method proposed in (e)(ii) would provide a benefit to humans.

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**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.**

3. Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

(a) **Describe** why coal is considered a nonrenewable energy source.

(b) **Describe** one potential environmental advantage of replacing a coal-fired power plant with a natural-gas power plant.

(c) **Describe** one economic advantage of using natural gas, rather than coal, in producing electricity.

(d) When natural gas is used to heat homes, it can produce carbon monoxide gas, which can lead to carbon monoxide poisoning in humans. **Propose** a solution to reduce the incidence of carbon monoxide poisoning in humans.

Particulate matter is another common pollutant in emissions from vehicles, coal-fired power plants, and various other sources. One size of particulates, $PM_{2.5}$, presents a particular risk to human health.

**ATMOSPHERIC CONCENTRATION OF PARTICULATE MATTER IN 1990 AND 2016**

| Year | Average Annual Atmospheric Concentration of $PM_{2.5}$ ($\mu g/m^3$) |
|---|---|
| 1990 | 85 |
| 2016 | 188 |

(e) **Calculate** the percent change in the average annual $PM_{2.5}$ concentration in the air from 1990 to 2016. **Show** your work.

(f) Trees can remove $PM_{2.5}$ from the atmosphere when particulates settle on the leaves and are subsequently washed onto soil by rain. The average annual removal of $PM_{2.5}$ is 2.3 kilograms per hectare. **Calculate** the decrease in $PM_{2.5}$ removal in kilograms if logging reduced a forested area from 50,000 hectares to 43,000 hectares. **Show** your work.

(g) Research has shown that hospital admissions for cardiovascular problems increase 1% with every 10% increase in $PM_{2.5}$ concentration. A city experienced a 23% increase in $PM_{2.5}$ concentration and had 7,390 hospital admissions for cardiovascular issues over a one-year period. **Calculate** the anticipated increase in the number of hospital admissions for cardiovascular issues during the next year if the $PM_{2.5}$ concentration continues to rise at an identical rate. **Show** your work.

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**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.**





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**END OF EXAM**

4. In many parts of the world, biomass like peat, wood, and animal waste is burned indoors for cooking and home heating. Combustion of these fuels releases harmful household air pollutants that pose a health threat to billions of people, mostly in less developed countries.

   (a) Air pollutants are released during the burning of biomass indoors for cooking and heating.

   (i) **Identify** TWO air pollutants released during the burning of biomass indoors for cooking and heating.

   (ii) **Identify** a specific human respiratory illness that one of the pollutants you identified may cause.

   (b) **Identify** one realistic approach, other than banning the practice of burning biomass indoors, that could be used to reduce the impact of biomass combustion indoors on human respiratory health. **Describe** how this approach could reduce the incidence of respiratory illness.

   In 2016 approximately four million people died from illnesses attributed to household air pollutants from burning biomass indoors. More than 10 percent of these deaths occurred in children under the age of five in less developed countries.

   (c) **Discuss** one reason children under the age of five are at a greater risk than adults for illnesses linked to household air pollutants.

   In more developed countries, indoor air pollution is also a problem. Common indoor air pollutants in developed countries include:

   - asbestos
   - radon
   - mold

   (d) Choose TWO of the three common indoor air pollutants (asbestos, radon, mold) listed above and complete the following table.

   (i) **Identify** a source for each indoor air pollutant.

   (ii) **Describe** a method for reducing exposure to each of the two pollutants you chose.

| Indoor Air Pollutant | Source | Method for Reducing Exposure |
|---|---|---|
| | | |
| | | |

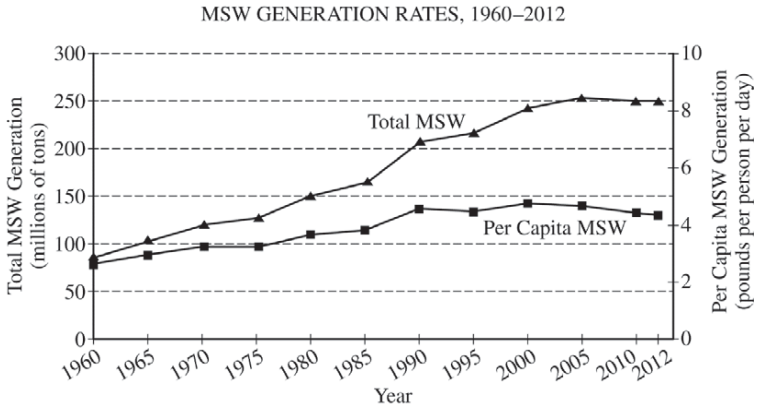
**STOP**

**END OF EXAM**





3. Municipal solid waste (MSW) is the trash collected from households and businesses. The graph below shows MSW generation in the United States from 1960 to 2012.




   (a) Use the data provided in the graph above to respond to the following.

   (i) **Explain** one probable cause (other than increased composting) for the change in per capita waste generation from 2000 to 2012.

   (ii) **Calculate** the percent increase in total MSW generation from 1980 to 2012.

   (b) Two ways of managing MSW are incineration and disposal in landfills.

   (i) **Identify** one disadvantage of waste incineration.

   (ii) **Identify** one disadvantage of waste disposal in landfills.

   Trash incineration is one way to generate electricity from MSW. Electricity can also be generated from waste buried in landfills.

   (c) **Describe** the specific steps of a process used to produce electricity from waste buried in a landfill.

   (d) Many landfills do not accept used tires. As a result, the tires are often dumped in poorly regulated piles. **Describe** one human health problem associated with piles of discarded tires.

   (e) Composting is one way to reduce the amount of waste that enters a landfill.

   (i) Other than reducing the volume of waste, **identify** one advantage of composting.

   (ii) **Identify** one disadvantage of composting.

2. Approximately 30 million mobile devices were sold in 1998 in the United States. The number sold increased to 180 million devices in 2007.

   (a) **Calculate** the percent increase of mobile device sales from 1998 to 2007.

   (b) Each mobile device sold in 2007 contained an average of 0.03 gram of gold. **Calculate** the number of grams of gold that were used in the production of the mobile devices sold in 2007.

   (c) Assume that the average mass of each mobile device was 0.1 kilogram. The United States Environmental Protection Agency estimates that about 10 percent of the mobile devices sold in 2007 were recycled. **Calculate** the mass (in kilograms) of the mobile devices sold in 2007 that were <u>not</u> recycled.

   (d) Discarded mobile devices become part of the electronic waste stream (e-waste). Mercury is often present in e-waste. **Identify** one negative human health effect, other than death, associated with exposure to mercury.

   (e) Improper disposal of e-waste has harmed human health and caused environmental damage in developing countries.

      (i) **State** TWO reasons why large quantities of e-waste from the United States are shipped to developing countries rather than being recycled in the United States.

      (ii) Retailers or manufacturers could take specific steps to dramatically reduce the amount of e-waste. **Describe** a realistic change in current practices that would accomplish this.



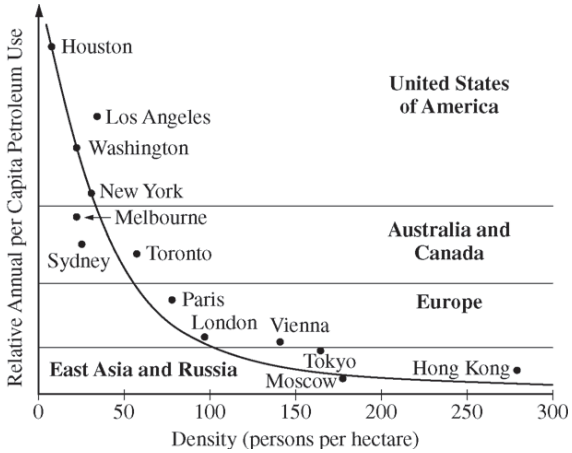


4. The term "urban sprawl" describes the expansion of cities into rural areas. This phenomenon has occurred around the world and has had economic, health, and environmental consequences.

   (a) **Describe** TWO causes of urban sprawl.

   (b) **Discuss** TWO human health effects associated with urban sprawl.

   (c) The graph below shows the relationship between population density and petroleum use in selected cities. **Describe** the relationship between population density and petroleum use shown in the graph.




   (d) Smart growth focuses on ways to encourage sustainable urban development. **Describe** TWO steps a municipality could take to encourage smart growth in order to limit urban sprawl.

   (e) Highway systems and urban sprawl often threaten wildlife populations. **Describe** TWO methods to reduce harmful effects on wildlife populations from highways and urban sprawl.

   (f) Urban sprawl often results in the loss of productive agricultural land near cities. **Describe** one practical way to increase food production within urban areas.

**STOP**

**END OF EXAM**