Past-paper walk-through

Pollution and Human Health ▪ 8.14

eXercise

Questions in this set

- 2023 Set 1 Q3
- 2022 Set 2 Q3
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- 2018 Q4
- 2016 Q3
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- 2015 Q4

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 3

2023 Set 1 ▪ Q3

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.

Question 3

(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

Solution 3

(a)

Mark scheme

- Any one environmental impact: marine life is harmed/killed by being coated/suffocated by oil from spills; animals are harmed/killed by ingesting spilled oil; oil slicks from spills can block sunlight from entering water and inhibit photosynthesis; oil that washes up on beaches/in marshes/in estuaries damages habitat; noise pollution disrupts marine animals' ability to communicate/mate/eat/evade prey; or CO2 from combustion of fuels in boats/equipment is absorbed by the ocean and contributes to ocean acidification.

Solution 3

(b)

Mark scheme

- Any one atmospheric pollutant: carbon dioxide (CO_2); nitrogen oxides (NO_x, NO, NO_2, N_2O); sulfur oxides (SO_x, SO_2, SO_3); particulate matter (PM); carbon monoxide (CO); or volatile organic compounds (VOCs).

Solution 3

(c)

Mark scheme

- Any one solution: ride a bike/scooter/skateboard or walk instead of driving; replace a gasoline/diesel powered car with a hybrid or electric vehicle; replace a gasoline/diesel powered car with one that utilizes alternative fuel (biodiesel, ethanol, hydrogen); buy/drive a more fuel-efficient vehicle; work from home/telecommute to reduce miles driven; choose housing close to employment to reduce miles driven; take public transportation instead of driving; carpool instead of driving alone; or combine trips to reduce miles driven.

Solution 3

(d)

Mark scheme

- Fewer air pollutants (particulates, NOx, VOCs, smog) from the proposed solution lead to lower rates of respiratory illness/problems (such as asthma, COPD, lung cancer), lower rates of cardiovascular illness (such as heart attacks), and less eye irritation. If the solution proposed in (c) was active transport (biking/walking/scootering), an additional acceptable justification is improved health/decreased risk of disease/cardiovascular illness from more physical activity/exercise.

Solution 3

(e)

Mark scheme

- Setup (1 point): 260×10^6 metric tons$\times \dfrac{5 \text{ grams}}{1 \text{ metric ton}}$ (equivalently $5 \times 260{,}000{,}000$). Calculation (1 point): $260{,}000{,}000 \times 5 = 1{,}300{,}000{,}000$ grams of gold (i.e. 1.3×10^9 g). Award 1 point for the correct dimensional setup and 1 point for the correct final numeric answer (1,300,000,000 g or 1.3 x $10^9 g$).

Solution 3

(f)

Mark scheme

- Setup (1 point): $\dfrac{\$62.56}{1\text{ gram}} \times 1{,}000\text{ metric tons} \times \dfrac{5\text{ grams}}{1\text{ metric ton}}$ (equivalently $1{,}000 \times 5 \times \$62.56$). Calculation (1 point): $1{,}000 \times 5 \times 62.56 = 312{,}800$, so the gold recovered from 1,000 metric tons of ore is worth $312,800. Award 1 point for the correct setup and 1 point for the correct final numeric answer ($312,800).

Solution 3

(g) Mark scheme

- Setup (1 point): $\dfrac{0.034 \text{ grams}}{1 \text{ cell phone}} \times \dfrac{1 \text{ metric ton}}{5 \text{ grams}} \times 100{,}000$ cell phones (equivalently $\dfrac{0.034 \times 100{,}000}{5}$). Calculation (1 point): $\dfrac{0.034 \times 100{,}000}{5} = \dfrac{3{,}400}{5} = 680$ metric tons of gold ore. Award 1 point for the correct setup and 1 point for the correct final numeric answer (680 metric tons).

Question 3

2022 Set 2 ▪ Q3

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.

Question 3

2022 Set 2 ▪ Q3

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.

(b)(i) 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.

Describe an environmental problem associated with coal ash waste disposal.

(b)(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.

Question 3

2022 Set 2 ▪ Q3

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.

(c)(i) 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

Question 3

Calculate the percent change in Charlotte's population from 2013 to 2019. **Show** your work.

(c)(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.

(c)(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.

Question 3

2022 Set 2 ▪ Q3

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.

(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.

Solution 3

(a)

Mark scheme

- Any one negative human health effect linked to pollutant exposure from coal combustion: lung/respiratory disease (asthma, COPD, bronchitis, lung cancer); neurological damage; birth defects; heart disease; eye irritation/respiratory irritation/headaches.

Solution 3

(b)(i)

Mark scheme

- Any one environmental problem associated with coal ash waste disposal: leaching from landfills/clay-lined pits; overflowing of coal ash into bodies of water; leaking and contamination of groundwater, soil, or nearby bodies of water; coal ash washing into bodies of water during severe weather events; dry ash blowing/carrying into nearby bodies of water, increasing turbidity/decreasing photosynthesis.

Solution 3

(b)(ii)

Mark scheme

- Clay is less permeable than unlined pits and can prevent the leaching of coal ash into soil/groundwater.

Solution 3

(c)(i)

Mark scheme

- Percent change $=$ [(857,425 people $-$ 757,278 people) / 757,278 people] $\times$ 100, equivalently [(857,425/757,278) $-$ 1] $\times$ 100. One point for this correct setup; one point for the correct result: $\approx$13% (13.22%, or 13.224602%).

(c)(ii)

Mark scheme

- Doubling time $=$ 70 / growth rate(%) $=$ 70 / 1.88 $\approx$ 37 years. One point for this correct setup. Adding 37 years to 2019 gives the doubling year: one point for the correct result, 2056.

Solution 3

(c)(iii)

Mark scheme

- Gallons used in 2018 = 90 gallons/person/day × 841,611 people × 365 days. One point for this correct setup. One point for the correct result: 27,646,921,350 gallons (accept 2.76×10^10, 2.8×10^10, or 3×10^10 gallons).

Solution 3

(d)

Mark scheme

- Any one realistic action to reduce domestic outdoor water use: plant drought-resistant species/use artificial landscaping/xeriscaping to reduce irrigation needs; eliminate/reduce nonessential water use such as washing cars or power washing; reduce sprinkler/irrigation use by monitoring soil/weather conditions or reducing frequency; collect rainwater or greywater for irrigation; water plants/lawn before sunrise/after sunset to limit evaporation; switch to drip irrigation to limit evaporation.

Question 2

2021 Set 1 ▪ Q2

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.

Question 2

2021 Set 1 ▪ Q2

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.

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

Question 2

2021 Set 1 ▪ Q2

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.

(c)(i) 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

Question 2

Use the data in the table to answer the following questions.
Identify the year when the pesticide was most effective at reducing the size of the pest population.
(c)(ii) Describe the change in the number of crop insect pests in the cotton fields over time.
(c)(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.

Question 2

2021 Set 1 ▪ Q2

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.

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

Question 2

2021 Set 1 ▪ Q2

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.

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

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

(e)(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.

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

Solution 2

(a)

Mark scheme

- One benefit to human health from pesticide use (accept one): pesticides control disease vectors such as mosquitoes, ticks, rats, and mice that spread disease to/between humans; they reduce exposure to stinging insects that carry disease; or they increase food production, which decreases famine / increases food availability and thereby improves human health.

Solution 2

(b)

Mark scheme

- One way chemical pesticides can enter the human body (accept one): inhalation/breathing in aerosols and powders (e.g. during application on farms, yards, golf courses); drinking water contaminated by pesticide runoff; consumption of food carrying pesticide residue; or dermal absorption through the skin during application of the pesticide.

Solution 2

(c)(i)

Mark scheme

- Identify the year the pesticide was most effective at reducing the pest population size: 1975 (the year of the initial application, when the number of crop insect pests captured was lowest).

Solution 2

(c)(ii)

Mark scheme

- Describe the change in the number of crop insect pests in the cotton fields over time: the pest population was high before the pesticide was first used, then dropped dramatically right after the initial 1975 application, and then increased again over subsequent years even as more pesticide (grams per hectare) was applied — overall, captures rose from about 2 pests in 1975 to about 1,100 pests by 2015 (roughly 700 to 1,100 across the full 1960–2015 span).

Solution 2

(c)(iii)

Mark scheme

- Explain how the change between the 1975 and 2015 applications illustrates genetic resistance: over time the same (or an increasing) amount of pesticide kills a smaller fraction of the pest population, because pests with a genetic resistance to the pesticide survive each application and reproduce, passing that resistance to their offspring. This is the "pesticide treadmill" — each year more pesticide must be applied, yet the number of pests captured (surviving) steadily increases, showing that an increasing share of the population carries genetic resistance to the pesticide.

Solution 2

(d) Mark scheme

- Describe TWO effects of pesticide use (other than death) on nontarget wildlife (accept any two): the pesticide may contaminate soil/water, negatively affecting organisms; it may bioaccumulate in an organism's body; it may biomagnify up the food web/chain; nontarget organism populations may increase where competitors/predators are removed and new habitat opens up; predator species may decrease, letting prey species grow rapidly; endocrine disruption may cause reproductive or developmental abnormalities; pesticides can disrupt signaling/communication in bees; they can cause eggshell thinning or other developmental abnormalities; or they can eliminate a food supply and disrupt the food chain for other species.

Solution 2

(e)(i)

Mark scheme

- Describe the process of crop rotation: growing different crops in succession (in different seasons or years) on the same piece of land, rather than growing the same crop repeatedly — i.e. harvesting one crop and then planting a different crop in that same area.

Solution 2

(e)(ii)

Mark scheme

- Propose one method, other than crop rotation, to reduce pesticide use while still maintaining a high crop yield (accept one): integrated pest management combining biological, physical, and chemical controls; reducing stubble/crop residue in fallow fields that harbor pests; applying pesticide only when the pest is most susceptible; intercropping instead of monoculture to reduce pest habitat; or using pest-resistant genetically modified crops.

Solution 2

(e)(iii)

Mark scheme

- Justify how the method proposed in (e)(ii) benefits humans (accept one): it reduces pesticide residue in food and pesticide ingested by humans; it provides economic benefits such as less money spent on pesticides, increased farmer profit from crops, and less equipment/labor needed to spray fields; or it reduces the number of agricultural workers exposed to pesticides, improving their health.

Question 3

2021 Set 2 ▪ Q3

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.

Question 3

2021 Set 2 ▪ Q3

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.

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

Question 3

2021 Set 2 ▪ Q3

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.

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

Question 3

2021 Set 2 ▪ Q3

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.

(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.

Question 3

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

Question 3

2021 Set 2 ▪ Q3

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.

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

Question 3

2021 Set 2 ▪ Q3

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.

(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.

Question 3

2021 Set 2 ▪ Q3

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.

(g) Research has shown that hospital admissions for cardiovascular problems increase 1

Solution 3

(a)

Mark scheme

- Coal is considered nonrenewable because it exists in a fixed/finite/limited amount – its natural formation rate is far slower than the rate at which it is consumed/combusted.

Solution 3

(b)

Mark scheme

- One environmental advantage of replacing a coal-fired plant with a natural-gas plant: natural gas combustion emits fewer greenhouse gases/less CO2; does not emit mercury/lead/cadmium/uranium; emits less NOx/SOx, reducing acid precipitation; produces less/no particulate matter/soot/smog; requires less habitat destruction/fossil-fuel use to transport than coal; avoids habitat destruction from impoundment of coal ash or coal slurry; or avoids the habitat destruction of strip mining/mountaintop removal used to extract coal.

Solution 3

(c) Mark scheme

- One economic advantage of natural gas over coal in producing electricity: pipeline transport of natural gas costs less than rail transport of coal; natural gas (methane) harvested from decomposition (landfills, wastewater treatment plants, biodigesters) costs less than coal; fewer health-related costs are linked to burning natural gas than coal; fewer pollution controls are needed for a natural-gas plant, lowering operating/construction/permitting costs; lower combustion-residue disposal costs than coal-burning plants; or natural-gas plants are more efficient (more electricity output per unit energy input), leading to lower fuel costs.

Solution 3

(d) Mark scheme

- A solution to reduce carbon monoxide poisoning: install/use/replace/update carbon monoxide detectors/alarms/sensors (or replace their batteries); perform regular maintenance on natural-gas furnaces so minimal carbon monoxide is produced and combustion products are properly vented/exhausted; create laws/regulations mandating carbon monoxide detectors in all homes; use PSAs, billboards, or other methods to educate the public about carbon monoxide poisoning; or change the home heating system to a method that does not involve combustion of a fuel that could produce carbon monoxide.

Solution 3

(e)

Mark scheme

- Percent change = [(188 micrograms/m^3 - 85 micrograms/m^3) / 85 micrograms/m^3] x 100 ~= 121% (accept 120% or 121.2%). One point for the correct setup (must include units and multiplication by 100 to yield a true percentage: (188-85)/85 x 100); one point for the correct numeric result (121%, 120%, or 121.2%).

Solution 3

(f)

Mark scheme

- Decrease in PM2.5 removal = (50,000 ha - 43,000 ha) x 2.3 kg/ha = 7,000 ha x 2.3 kg/ha = 16,100 kg (accept 16,000 kg). Equivalently: 50,000 ha x 2.3 kg/ha = 115,000 kg; 43,000 ha x 2.3 kg/ha = 98,900 kg; 115,000 kg - 98,900 kg = 16,100 kg. One point for the correct setup (must include units); one point for the correct numeric result (16,100 kg or 16,000 kg).

Solution 3

(g)

Mark scheme

- Increase in admissions = (0.23/0.10) x 0.01 x 7,390 admissions, equivalently (23%/10%) x 1% x 7,390 admissions ~= 169-170 more admissions (accept 169 or 170). One point for the correct setup; one point for the correct numeric result.

Question 4

2018 ▪ Q4

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

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

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

Question 4

Indoor Air Pollutant	Source	Method for Reducing Exposure

Question 4

2018 ▪ Q4

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.

(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.

Question 4

2018 ▪ Q4

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.

(c) 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.

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

Question 4

2018 ▪ Q4

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.

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

- asbestos
- radon
- mold

Question 4

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

Indoor Air Pollutant	**Source**	**Method for Reducing Exposure**

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

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

Solution 4

(a)(i)

Mark scheme

- 2 points, 1 point per correctly identified air pollutant released during indoor biomass burning (up to 2). Accept any two of: carbon monoxide (CO); particulate matter (PM); nitrogen oxides (NOx); sulfur oxides (SOx); trace metals such as lead, mercury, arsenic, and cadmium; methane (CH4); volatile organic compounds (VOCs).

Solution 4

(a)(ii)

Mark scheme

- 1 point for correctly identifying a specific human respiratory illness linked to one of the identified pollutants. Accept, matched to the pollutant: CO $\rightarrow$ CO poisoning; PM $\rightarrow$ asthma, chronic obstructive pulmonary disease (COPD), emphysema, bronchitis, or lung cancer; NOx $\rightarrow$ pneumonia or asthma; SOx $\rightarrow$ bronchitis, emphysema, or asthma; trace metals (lead, mercury, arsenic, cadmium) $\rightarrow$ bronchitis; methane $\rightarrow$ bronchitis; VOCs $\rightarrow$ bronchitis or asthma.

Solution 4

(b) Mark scheme

- 2 points: 1 for identifying a realistic approach (other than banning indoor biomass burning) to reduce its impact on respiratory health, 1 for describing how that identified approach reduces the incidence of respiratory illness. Accept any one matched pair: ventilate through structural change (chimney construction, opening windows and doors) — removes some or all of the air pollution from indoors/transfers pollutants out of the home, leading to less respiratory illness; switch to a cleaner-burning/more efficient cooking stove — requires less fuel to be burned, releasing fewer air pollutants into the home; switch to a different energy source (solar, natural gas, biogas, electric) — produces less or no indoor air

Solution 4

pollutants; cook outdoors — moves the source of air pollutant outside/leads to less or no concentrated air pollution inside.

Solution 4

(c)

Mark scheme

- 1 point for a correct discussion of why children under age five are at greater risk than adults for illnesses linked to household air pollutants. Accept any one of: children have an underdeveloped/less-developed immune system, leading to a greater risk of illness following exposure; children have a lower body mass, leading to a higher relative dose of air pollution; children spend more time indoors, leading to higher exposure to air pollution; children have smaller respiratory systems (narrow airways) so mild inflammation may cause more severe respiratory distress.

Solution 4

(d) Mark scheme

- 4 points total for choosing TWO of asbestos/radon/mold and completing the table: 1 point for each correctly identified source (up to 2, one per chosen pollutant) and 1 point for each correctly described method of reducing exposure (up to 2, one per chosen pollutant). Asbestos — source: building materials (cement, floor tiles, ceiling panels, drywall, popcorn ceiling), insulation, or naturally occurring in soil/rock in a dirt-floor basement/crawlspace; method: safely remove asbestos-containing materials/abatement, encapsulate/cover/seal materials or construct a temporary enclosure, or leave undisturbed. Radon — source: soil, rocks, Earth's crust; gas from uranium-containing rocks; gas penetrating the foundation; method: seal floors/walls/joints, install structural

Solution 4

exhaust venting, or install a subfloor depressurizing system. Mold — source: water from flooding/natural disasters/leaks, or poorly vented/maintained damp environments; method: replace or repair damaged surfaces/structures, clean/disinfect affected areas, dehumidify or ventilate inside air, or improve drainage (from roof or yard, sump pump the basement). Award points for any two of the three pollutants chosen.

Question 3

2016 ▪ Q3

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. [Line graph titled “MSW GENERATION RATES, 1960-2012”. Left y-axis: “Total MSW Generation (millions of tons)”, scale 0 to 300 in increments of 50. Right y-axis: “Per Capita MSW Generation (pounds per person per day)”, scale 0 to 10 in increments of 2. X-axis: “Year”, from 1960 to 2012 in 5-year increments (1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2012).

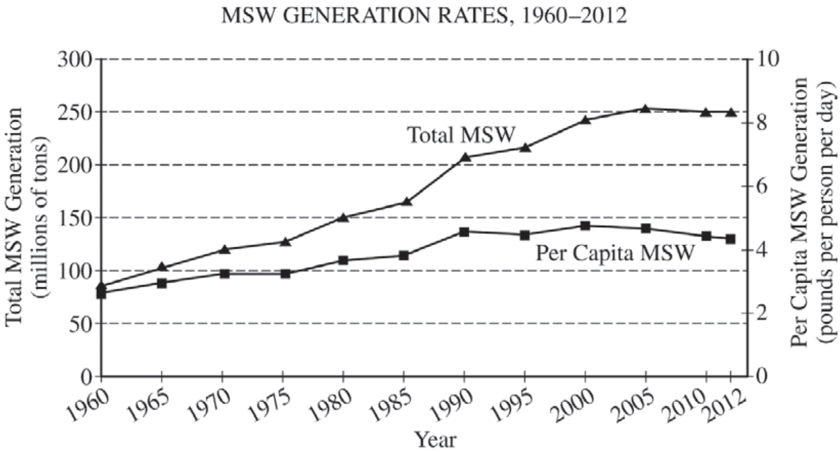
Line labeled “Total MSW” (triangles), approximate values: 1960 $\approx$ 80, 1965 $\approx$ 105, 1970 $\approx$ 120, 1975 $\approx$ 128, 1980 $\approx$ 150, 1985 $\approx$ 165, 1990 $\approx$ 205, 1995 $\approx$ 215, 2000 $\approx$ 240, 2005 $\approx$ 252, 2010 $\approx$ 250, 2012 $\approx$ 250.

Question 3

Line labeled "Per Capita MSW" (squares), approximate values: 1960 $\approx$ 2.6, 1965 $\approx$ 2.8, 1970 $\approx$ 3.2, 1975 $\approx$ 3.2, 1980 $\approx$ 3.6, 1985 $\approx$ 3.7, 1990 $\approx$ 4.5, 1995 $\approx$ 4.4, 2000 $\approx$ 4.7, 2005 $\approx$ 4.6, 2010 $\approx$ 4.4, 2012 $\approx$ 4.2.]

(a)(i) Use the data provided in the graph above to respond to the following.
Explain one probable cause (other than increased composting) for the change in per capita waste generation from 2000 to 2012.
(a)(ii) **Calculate** the percent increase in total MSW generation from 1980 to 2012.

Question 3



MSW GENERATION RATES, 1960–2012
Total MSW Generation (millions of tons)
Per Capita MSW Generation (pounds per person per day)
Total MSW
Per Capita MSW
Year
0
50
100
150
200
250
300
0
2
4
6
8
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2012

Question 3

2016 ▪ Q3

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.
[Line graph titled "MSW GENERATION RATES, 1960-2012". Left y-axis: "Total MSW Generation (millions of tons)", scale 0 to 300 in increments of 50. Right y-axis: "Per Capita MSW Generation (pounds per person per day)", scale 0 to 10 in increments of 2. X-axis: "Year", from 1960 to 2012 in 5-year increments (1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2012).
Line labeled "Total MSW" (triangles), approximate values: 1960 $\approx$ 80, 1965 $\approx$ 105, 1970 $\approx$ 120, 1975 $\approx$ 128, 1980 $\approx$ 150, 1985 $\approx$ 165, 1990 $\approx$ 205, 1995 $\approx$ 215, 2000 $\approx$ 240, 2005 $\approx$ 252, 2010 $\approx$ 250, 2012 $\approx$ 250.

Line labeled "Per Capita MSW" (squares), approximate values: 1960 $\approx$ 2.6, 1965 $\approx$ 2.8, 1970 $\approx$ 3.2, 1975 $\approx$ 3.2, 1980 $\approx$ 3.6, 1985 $\approx$ 3.7, 1990 $\approx$ 4.5, 1995 $\approx$ 4.4, 2000 $\approx$ 4.7, 2005 $\approx$ 4.6, 2010 $\approx$ 4.4, 2012 $\approx$ 4.2.]

Question 3

(b)(i) Two ways of managing MSW are incineration and disposal in landfills. **Identify** one disadvantage of waste incineration.
(b)(ii) Identify one disadvantage of waste disposal in landfills.

Question 3

2016 ▪ Q3

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.
[Line graph titled "MSW GENERATION RATES, 1960-2012". Left y-axis: "Total MSW Generation (millions of tons)", scale 0 to 300 in increments of 50. Right y-axis: "Per Capita MSW Generation (pounds per person per day)", scale 0 to 10 in increments of 2. X-axis: "Year", from 1960 to 2012 in 5-year increments (1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2012).
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Question 3

(c) Trash incineration is one way to generate electricity from MSW. Electricity can also be generated from waste buried in landfills.
Describe the specific steps of a process used to produce electricity from waste buried in a landfill.

Question 3

2016 ▪ Q3

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.
[Line graph titled "MSW GENERATION RATES, 1960-2012". Left y-axis: "Total MSW Generation (millions of tons)", scale 0 to 300 in increments of 50. Right y-axis: "Per Capita MSW Generation (pounds per person per day)", scale 0 to 10 in increments of 2. X-axis: "Year", from 1960 to 2012 in 5-year increments (1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2012).
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Question 3

(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.

Question 3

2016 ▪ Q3

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.
[Line graph titled "MSW GENERATION RATES, 1960-2012". Left y-axis: "Total MSW Generation (millions of tons)", scale 0 to 300 in increments of 50. Right y-axis: "Per Capita MSW Generation (pounds per person per day)", scale 0 to 10 in increments of 2. X-axis: "Year", from 1960 to 2012 in 5-year increments (1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2012).
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Line labeled "Per Capita MSW" (squares), approximate values: 1960 $\approx$ 2.6, 1965 $\approx$ 2.8, 1970 $\approx$ 3.2, 1975 $\approx$ 3.2, 1980 $\approx$ 3.6, 1985 $\approx$ 3.7, 1990 $\approx$ 4.5, 1995 $\approx$ 4.4, 2000 $\approx$ 4.7, 2005 $\approx$ 4.6, 2010 $\approx$ 4.4, 2012 $\approx$ 4.2.]

Question 3

(e)(i) Composting is one way to reduce the amount of waste that enters a landfill. Other than reducing the volume of waste, **identify** one advantage of composting.
(e)(ii) **Identify** one disadvantage of composting.

Solution 3

(a)(i)

Mark scheme

- 1 point for a correct explanation (other than increased composting) for the change in per capita waste generation from 2000 to 2012: people/businesses practicing refuse, reduce, reuse, recycle, or repurpose; lighter materials contribute to less MSW (e.g., plastic bottles instead of glass); less material used per product (e.g., thinner newspapers, lighter aluminum cans); technology reduces waste generation (e.g., reading magazines online instead of on paper); or economic recession leading to less consumption and less MSW produced.

Solution 3

(a)(ii)

Mark scheme

- 1 point for the correct answer with work shown: ((250 million tons − 150 million tons) / 150 million tons) $\times$ 100 = 66% to 67% increase in total MSW generation from 1980 to 2012.

Solution 3

(b)(i)

Mark scheme

- 1 point for a correct identification of a disadvantage of waste incineration: releases a specific air pollutant (e.g., CO, CO2, dioxin, halogens, particulates, SOx, NOx); ash disposal is necessary; incinerators are expensive to construct and/or operate; MSW supply/quality may be limited, requiring additional fuel; or reduced quality of life and property value due to the incinerator and supply trucks.

Solution 3

(b)(ii)

Mark scheme

- 1 point for a correct identification of a disadvantage of waste disposal in landfills: groundwater, surface water, or soil contamination through some transport mechanism; reduced quality of life and property value due to the landfill and supply trucks; release of methane or CO_2; odor source; attracts vermin; habitat destruction; precludes other land uses; or explosion/seepage hazard from methane produced.

Solution 3

(c)

Mark scheme

- 3 points, 1 point for each correct step in the process of generating electricity from landfill gas: (1) Acquire fuel (chemical energy) — methane is collected/gathered from the landfill; (2) Use fuel (chemical $\rightarrow$ mechanical) — the fuel is combusted to produce steam or hot air; (3) Generate electricity (mechanical $\rightarrow$ electricity) — the steam or hot air spins/turns/rotates a turbine/generator to generate/produce electricity.

Solution 3

(d)

Mark scheme

- 1 point for a correct description of a human health problem associated with piles of discarded tires: discarded tires provide standing-water habitat for mosquitoes/pests that can act as disease vectors; or tires may catch fire and release air pollutants that cause respiratory issues in humans.

Solution 3

(e)(i)

Mark scheme

- 1 point for a correct identification of an advantage of composting (other than reducing waste volume): the resulting compost can be used or sold as fertilizer or soil amendment; municipal composting facilities may provide jobs; MSW may emit less foul odor if organic material is composted; or tipping fees and trash removal costs may be reduced by removing dense compostable material.

Solution 3

(e)(ii)

Mark scheme

- 1 point for a correct identification of a disadvantage of composting: compost may attract undesirable animals (vermin); compost may emit foul odors or spontaneously combust; nutrients released from decomposing organic matter may run off into surface waters and cause water quality problems; compost may release methane; or composting organic material requires a great investment of time and labor by humans.

Question 2

2015 ▪ Q2

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.

Question 2

2015 ▪ Q2

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

Question 2

2015 ▪ Q2

Approximately 30 million mobile devices were sold in 1998 in the United States. The number sold increased to 180 million devices 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 not recycled.

Question 2

2015 ▪ Q2

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

(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.

Question 2

2015 ▪ Q2

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

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

(e)(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.

(e)(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.

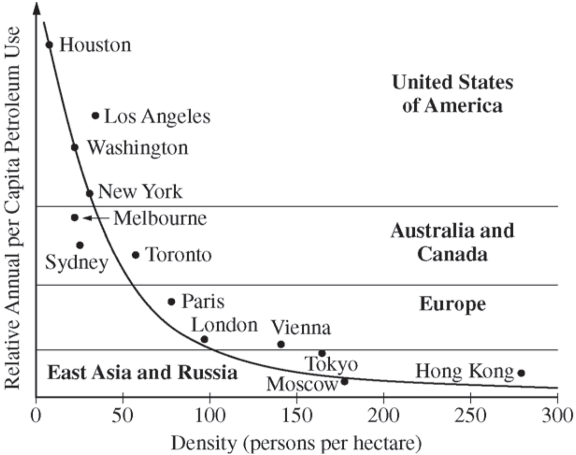
Question 4

2015 ▪ Q4

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.

Question 4



Relative Annual per Capita Petroleum Use
Houston
Los Angeles
Washington
New York
Melbourne
Sydney
Toronto
Paris
London
Vienna
Tokyo
Moscow
Hong Kong
United States of America
Australia and Canada
Europe
East Asia and Russia
0
50
100
150
200
250
300
Density (persons per hectare)

Question 4

2015 ▪ Q4

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.

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

Question 4

2015 ▪ Q4

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.

(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.

[Scatter/line graph titled with axes: y-axis "Relative Annual per Capita Petroleum Use" (unlabeled scale, decreasing curve), x-axis "Density (persons per hectare)" from 0 to 300 in increments of 50. A smooth downward-sloping curve passes near the plotted city points, showing petroleum use falling sharply as density rises then leveling off. Points, grouped by horizontal banding into four labeled regions from top to bottom ("United States of America", "Australia and Canada", "Europe", "East Asia and Russia"):

Question 4

- Houston: very low density (~10), highest petroleum use, in "United States of America" band
- Los Angeles: low density (~25), high petroleum use, in "United States of America" band
- Washington: low density (~30), high petroleum use, in "United States of America" band
- New York: low-moderate density (~40), moderate-high petroleum use, in "United States of America" band
- Melbourne: density (~30), at top of "Australia and Canada" band
- Sydney: density (~25), in "Australia and Canada" band
- Toronto: density (~45), in "Australia and Canada" band
- Paris: density (~100), at top of "Europe" band

Question 4

- London: density (~100), in "Europe" band
- Vienna: density (~170), in "Europe" band
- Moscow: density (~180), at top of "East Asia and Russia" band
- Tokyo: density (~185), in "East Asia and Russia" band
- Hong Kong: density (~280), lowest petroleum use, in "East Asia and Russia" band]

Question 4

2015 ▪ Q4

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.

(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.

Question 4

2015 ▪ Q4

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.

(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.

Question 4

2015 ▪ Q4

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.

(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.