Past-paper walk-through

Sustainable Agriculture ▪ 5.15

eXercise

Questions in this set

- 2025 Set 2 Q2
- 2024 Set 1 Q2
- 2022 Set 2 Q2
- 2021 Set 1 Q2
- 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 2

2025 Set 2 ▪ Q2

Serengeti National Park is located in Tanzania, Africa. The park is located in a valley along a tectonic plate boundary called the East African Rift. Figure 1 shows the East African Rift and other plate boundaries near the east coast of Africa.

Figure 1. Tectonic Plate Movement near East Coast of Africa

[Map figure showing tectonic plates near the east coast of Africa. Labels: “Arabian Plate” (north-central), “African Plate” (west), “Indian Plate” (east), “Lake Victoria” (small lake, west, with an arrow pointing away from it/west), “Western Rift Valley” and “Eastern Rift Valley” (two branching rift lines running north-south through the African Plate), “Serengeti National Park” (marked at the point where the Western and Eastern Rift Valleys meet), “Indian Ocean” (to the east). Bold arrows show direction of plate movement: one arrow points west/away from Lake Victoria area, one arrow points southeast from the rift valley junction, and a double-headed arrow (pointing

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Figure 2. Annual Migration of Wildebeest in Serengeti National Park

[Circular diagram showing the annual wildebeest migration route around Serengeti National Park, with a wildebeest icon and arrows connecting labelled month boxes in a loop: June → July → August → September → October (near "Ikorongo Game

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Reserve") → November (near "Loliondo") → December (near "Ngorongoro Conservation Area") → January → February → March → April (near "Maswa Game Reserve") → May → back to June. "Grumeti Game Reserve" is labelled near June/July. A dashed line labelled "Proposed location for new highway" crosses the northern part of the park near August/September. A solid line marks the "Serengeti National Park boundary." A compass rose (N/E/S/W) is in the bottom right. Legend: arrow = Wildebeest migration route; wildebeest icon = Wildebeest; dashed line = Proposed location for new highway; solid line = Serengeti National Park boundary.]
Respond to parts A, B, C, D, E, F, G, H, I, and J.

(a) Based on the information in Figure 1, **identify** the type of plate boundary that runs beneath Serengeti National Park.

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Respond to parts A, B, C, D, E, F, G, H, I, and J.

(b) Based on the information provided, **identify** the dominant biome within the Serengeti.

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Respond to parts A, B, C, D, E, F, G, H, I, and J.

(c) Wildebeest give birth to their young when new grasses are growing. Based on the information in Figure 2, **identify** the location in the Serengeti where wildebeest are most likely to give birth.

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Respond to parts A, B, C, D, E, F, G, H, I, and J.

(d) The Serengeti has two primary types of grasses: long and short. The two grass types provide similar levels of nutrition for animals. Wildebeest primarily consume long grasses, while other herbivores such as gazelle consume the short grasses. These two similar species coexist in Serengeti National Park.

Explain why resource partitioning allows for the coexistence of the wildebeest and the gazelle in the Serengeti.

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Respond to parts A, B, C, D, E, F, G, H, I, and J.

(e) The Tanzanian government plans to build a highway across the northern portion of the Serengeti, as shown in Figure 2.

Describe one way the planned highway shown in Figure 2 could negatively affect the wildebeest population in the Serengeti.

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Respond to parts A, B, C, D, E, F, G, H, I, and J.

(f) Propose a solution to the negative effect created by the planned highway described in part E.

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Respond to parts A, B, C, D, E, F, G, H, I, and J.

(g) Many organisms live in grasslands. One weed species, the spotted knapweed, was introduced at one location in North America in the 1890s and is currently found throughout the rangelands of the western United States. The spotted knapweed poses several environmental problems in North America. Farmers often use crop rotation to control populations of pests like the spotted knapweed. A more traditional method of controlling pests involves spraying pesticides.

Describe a characteristic of an invasive species, such as the spotted knapweed, that allows them to outcompete native species.

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Respond to parts A, B, C, D, E, F, G, H, I, and J.

(h) Justify the use of crop rotation as an environmental solution by providing an additional advantage, other than controlling pest populations.

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Respond to parts A, B, C, D, E, F, G, H, I, and J.

(i) Describe an environmental problem associated with controlling pest populations with large amounts of pesticide.

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Respond to parts A, B, C, D, E, F, G, H, I, and J.

(j) Propose a solution to controlling pests, other than pesticides or crop rotation.

Solution 2

(a)

Mark scheme

- Divergent (boundary) - the plate boundary running beneath Serengeti National Park (part of the East African Rift) is a divergent boundary. 1 point for identifying it as divergent.

Solution 2

(b)

Mark scheme

- The dominant biome within the Serengeti is savanna (tropical grassland). 1 point for identifying savanna/tropical grassland.

Solution 2

(c)

Mark scheme

- Wildebeest are most likely to give birth in the Grumeti Game Reserve, i.e. the west/northwestern side/edge of Serengeti National Park, where new grasses are growing (per Figure 2). 1 point for identifying this location.

Solution 2

(d)

Mark scheme

- Resource partitioning allows wildebeest (which eat long grasses) and gazelle (which eat short grasses) to coexist because it reduces the negative impact of competition for limited resources - each species uses the shared, limited resource (grass) in a different way (different grass types), so they are not competing directly for the exact same food source. 1 point for explaining this reduced-competition mechanism.

Solution 2

(e)

Mark scheme

- One way the planned highway could negatively affect the wildebeest population: building the highway would fragment/destroy habitat, food, or resources; the highway could prevent, reduce, or disturb migration; wildebeest could be hit/killed by vehicles; or noise pollution from the highway could cause stress or change migratory routes. 1 point for any one valid negative effect.

Solution 2

(f) Mark scheme

- A realistic solution must correspond to the problem identified in part E. If habitat fragmentation/destruction was described: construct a habitat corridor over/under the highway, construct the highway over/above the habitat, relocate the highway north/outside the migratory path, or expand the national park/create additional protected habitat. If migration disturbance or vehicle strikes was described: relocate the highway north/outside the migratory path, or construct a habitat corridor over/under the highway. If noise pollution/stress was described: install a sound barrier to mitigate noise pollution, or relocate the highway north/outside the migratory path. 1 point for a solution that logically addresses the specific problem given in part E.

Solution 2

(g)

Mark scheme

- A characteristic of an invasive species (such as spotted knapweed) that allows it to outcompete native species: it has many offspring/reproduces quickly/matures early/invests minimal energy per offspring (tends to be r-selected); it can feed on/use many different types of resources; or it can survive in conditions outside its normal habitat/has a wide tolerance range (tends to be a generalist). 1 point for any one valid characteristic.

Solution 2

(h)

Mark scheme

- An additional advantage of crop rotation (besides pest control): improved soil fertility/soil structure/soil quality; increased nutrient cycling/reduced need for fertilizer; reduced soil erosion; increased food security/crop yield; or increased biological activity in the soil. 1 point for any one valid additional advantage.

Solution 2

(i)

Mark scheme

- An environmental problem from controlling pests with large amounts of pesticide: pesticides can harm/kill nontarget species, or pests can develop resistance to the pesticide (leading to a pesticide treadmill). 1 point for either problem.

Solution 2

(j)

Mark scheme

- A solution to controlling pests other than pesticides or crop rotation: use biocontrol/intercropping/natural predators; trap insects/use mechanical controls to eliminate pests; or use genetically modified crops that are pest resistant. 1 point for any one valid alternative solution.

Question 2

2024 Set 1 ▪ Q2

As the human population continues to grow, the demand for animal protein is expected to double by 2050. Animal protein can be obtained from conventional livestock and other sources. The production of all animal protein has environmental costs, as shown in the following graphs. In Figure 1, global warming potential (GWP) is measured in kilograms of carbon dioxide equivalent (kg CO_2-eq). Carbon dioxide equivalent is a measure of the warming effect of a gas relative to that of carbon dioxide. In Figure 2, land use is measured in meters squared (m^2).
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Question 2

[Figure 2: bar graph titled "Figure 2". Y-axis "Land Use (m^2)" from 0 to 200 in increments of 20. X-axis "Production of 1 kg of Animal Protein" with four bars: Mealworms (18), Chicken (50), Pork (53), Beef (188).]

(a) Based on the data in the graphs, **identify** the amount of land required to produce 1 kilogram of chicken protein.

Mealworms, the larvae of the darkling beetle, consume grains and decaying plant material. Darkling beetles are an *r*-selected species, and the entire mealworm can be consumed by humans for protein.

Question 2

Figure 1

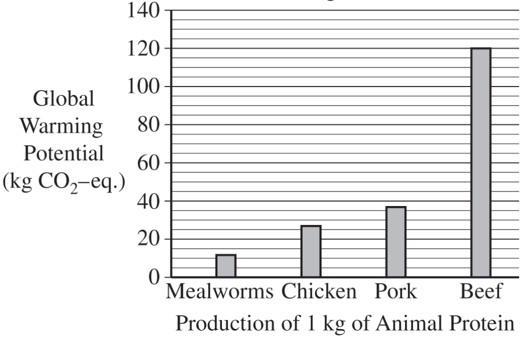
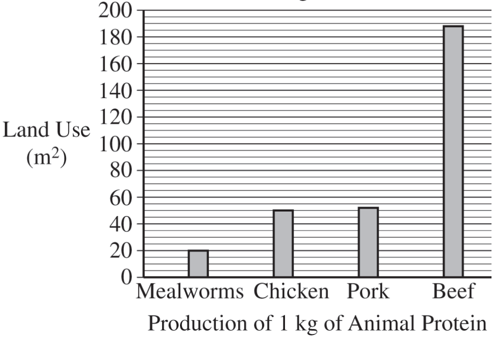


Figure 2



Question 2

2024 Set 1 ▪ Q2

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Question 2

(b) Based on the information provided, **identify** the type of survivorship curve exhibited by the darkling beetle.

Question 2

2024 Set 1 ▪ Q2

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Question 2

(c) Explain why the reproductive strategy of the darkling beetle is an advantage for using mealworms as an alternative protein source for the rapidly growing human population.

An individual's diet choices affect greenhouse gas emissions and land use.

Question 2

2024 Set 1 ▪ Q2

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Question 2

(d) Based on the data in the graphs, **explain** whether producing 1 kilogram of chicken protein or 1 kilogram of pork protein would cause less environmental damage.
Cattle emit methane from fermentation in their digestive systems. The other animals do not emit methane.

Question 2

2024 Set 1 ▪ Q2

As the human population continues to grow, the demand for animal protein is expected to double by 2050. Animal protein can be obtained from conventional livestock and other sources. The production of all animal protein has environmental costs, as shown in the following graphs. In Figure 1, global warming potential (GWP) is measured in kilograms of carbon dioxide equivalent (kg CO_2-eq). Carbon dioxide equivalent is a measure of the warming effect of a gas relative to that of carbon dioxide. In Figure 2, land use is measured in meters squared (m^2).
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Question 2

(e) Based on the data in the graphs, **explain** why the production of 1 kilogram of beef protein has a different impact on global warming than the production of 1 kilogram of protein from any of the other animals studied would have.

Agricultural practices can have negative impacts on rivers and streams.

Question 2

2024 Set 1 ▪ Q2

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Question 2

(f) Describe how water quality can be altered by cattle grazing that occurs near a stream or river.

Question 2

2024 Set 1 ▪ Q2

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Question 2

(g) Propose a solution to reduce the negative impacts on waterways that result from cattle grazing, while still allowing cattle to graze.

Question 2

2024 Set 1 ▪ Q2

As the human population continues to grow, the demand for animal protein is expected to double by 2050. Animal protein can be obtained from conventional livestock and other sources. The production of all animal protein has environmental costs, as shown in the following graphs. In Figure 1, global warming potential (GWP) is measured in kilograms of carbon dioxide equivalent (kg CO_2-eq). Carbon dioxide equivalent is a measure of the warming effect of a gas relative to that of carbon dioxide. In Figure 2, land use is measured in meters squared (m^2).

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Question 2

(h) Crop production can cause soil erosion. **Describe** a sustainable agricultural practice used to reduce soil erosion.

Question 2

2024 Set 1 ▪ Q2

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Question 2

(i) Justify the use of the sustainable practice described in part (h) by describing an additional advantage, other than the reduction of soil erosion.

Question 2

2024 Set 1 ▪ Q2

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Question 2

(j) Crop production around the world is affected by climate change. **Describe** how crop production could be negatively affected by climate change.

Solution 2

(a)

Mark scheme

- 50 m^2 of land is required to produce 1 kilogram of chicken protein (read from the graph).

Solution 2

(b)

Mark scheme

- The darkling beetle exhibits a Type III survivorship curve (high mortality early in life, few survivors reach old age — consistent with an r-selected species).

Solution 2

(c)

Mark scheme

- Darkling beetles are r-selected and reproduce quickly with many offspring, which allows a large amount of protein (mealworm biomass) to be produced in a short period of time — an advantage for feeding a rapidly growing human population.

Solution 2

(d)

Mark scheme

- Producing 1 kg of chicken protein causes less environmental damage than producing 1 kg of pork protein: chicken production has a lower global warming potential (releases less greenhouse gas) than pork, and/or chicken has lower land use than pork, so it causes less deforestation/habitat destruction/soil erosion/fossil fuel use.

Solution 2

(e)

Mark scheme

- Beef production has a larger impact on global warming than the other animals studied because cattle emit methane from digestive (enteric) fermentation, and methane is a greenhouse gas with a high global warming potential; beef also requires much more land use, which causes loss of forests/habitat/grasslands and releases stored $CO2$ (reducing carbon storage).

Solution 2

(f)

Mark scheme

- Cattle grazing near a stream or river can alter water quality by: causing erosion that increases sedimentation/turbidity in the water; adding nutrients (nitrogen/phosphorus) to waterways via feces; and/or contaminating waterways with bacteria from feces.

Solution 2

(g)

Mark scheme

- A solution that reduces waterway damage while still allowing grazing: practice rotational grazing (alternate grazing parcels so land can recover); reduce dietary reliance on meat/beef; fence/barricade the riparian zone to keep cattle out of the waterway; or provide alternative water sources for the cattle away from the stream.

Solution 2

(h)

Mark scheme

- A sustainable agricultural practice to reduce soil erosion: switch crops to perennial plants; plant crops on terraces; implement contour plowing/farming; or use no-till farming/cover crops.

Solution 2

(i)

Mark scheme

- Justify the practice named in part (h) with an advantage beyond reduced erosion. Matching the scoring table: perennial crops or no-till/cover crops $\rightarrow$ reduce fossil fuel use, reduce farming costs, increase/maintain soil carbon storage, and preserve soil habitat for organisms (cover crops can also serve as green manure); terracing or contour plowing $\rightarrow$ allows otherwise-too-steep areas to be farmed and increases groundwater absorption (terracing also lets sediment/contaminants settle out behind the ridge, further reducing runoff).

Solution 2

(j)

Mark scheme

- Climate change could negatively affect crop production/yields through: increased drought; increased flooding; increased insect infestation due to warmer temperatures; increased temperature generally; changes in seasonal rain patterns; expansion of the geographic range of invasive pests/species; or climate conditions moving outside crops' range of tolerance.

Question 2

2022 Set 2 ▪ Q2

Biologists collected data on the abundance of lizards on several Pacific islands with and without mongoose populations. The surveys were conducted at different locations on the islands by counting the number of lizards observed per hour and included habitats with both undisturbed areas and anthropogenically disturbed areas. [Scatter/line graph titled "LIZARD NUMBERS ON PACIFIC ISLANDS". Y-axis: "Lizards Counted per Hour", logarithmic scale from 10^0 to 10^3. X-axis: "Habitat Types", with categories in order from "Undisturbed" to "Highly disturbed": Primary Forest, Secondary Forest, Clearings, Gardens, Sugarcane Fields, Hotels, Parks, and Walking Trails. Two data series with individual data points and a smoothed trend curve for each: "Mongoose-free islands" (filled circles, solid curve) and "Mongoose-present islands" (open squares, dashed curve). Both curves rise from Primary Forest, peak around Clearings, Gardens (mongoose-free peak $\approx$ 50

Question 2

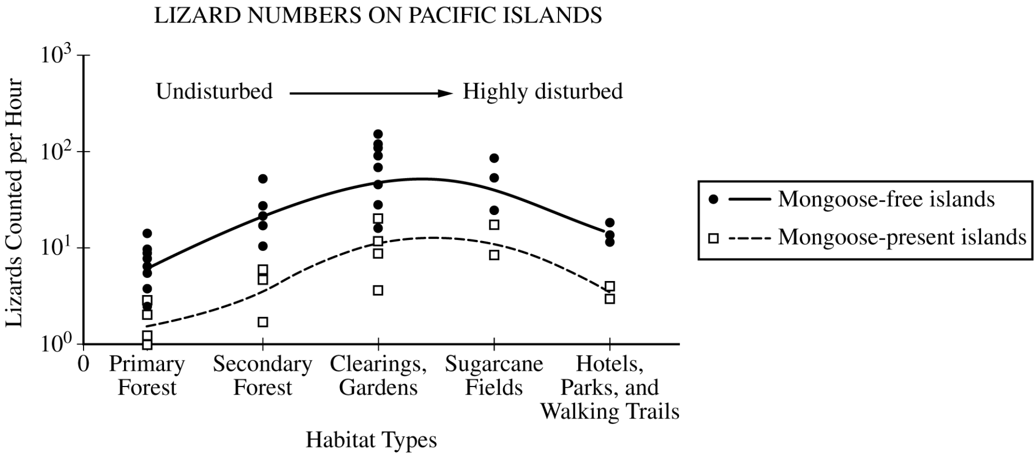
lizards/hour; mongoose-present peak $\approx$ 10 lizards/hour), then decline toward Hotels, Parks, and Walking Trails (mongoose-free $\approx$ 15 lizards/hour; mongoose-present $\approx$ 3 lizards/hour). At every habitat type, the mongoose-free (solid) curve lies above the mongoose-present (dashed) curve.]

(a)(i) The graph shows data collected by biologists on lizard numbers on several Pacific islands.

Based on the data in the graph, **identify** the habitat type with the greatest number of lizards.

(a)(ii) Based on the data in the graph, **describe** the relationship between the lizard numbers observed on islands with and without mongoose populations.

Question 2



LIZARD NUMBERS ON PACIFIC ISLANDS
Undisturbed
Highly disturbed
Lizards Counted per Hour
10^3
10^2
10^1
10^0
0
Primary Forest
Secondary Forest
Clearings, Gardens
Sugarcane Fields
Hotels, Parks, and Walking Trails
Habitat Types
Mongoose-free islands
Mongoose-present islands

Question 2

2022 Set 2 ▪ Q2

Biologists collected data on the abundance of lizards on several Pacific islands with and without mongoose populations. The surveys were conducted at different locations on the islands by counting the number of lizards observed per hour and included habitats with both undisturbed areas and anthropogenically disturbed areas.

[Scatter/line graph titled "LIZARD NUMBERS ON PACIFIC ISLANDS". Y-axis: "Lizards Counted per Hour", logarithmic scale from 10^0 to 10^3. X-axis: "Habitat Types", with categories in order from "Undisturbed" to "Highly disturbed": Primary Forest, Secondary Forest, Clearings, Gardens, Sugarcane Fields, Hotels, Parks, and Walking Trails. Two data series with individual data points and a smoothed trend curve for each: "Mongoose-free islands" (filled circles, solid curve) and "Mongoose-present islands" (open squares, dashed curve). Both curves rise from Primary Forest, peak around Clearings, Gardens (mongoose-free peak $\approx$ 50 lizards/hour; mongoose-present peak $\approx$ 10 lizards/hour), then decline toward

Question 2

Hotels, Parks, and Walking Trails (mongoose-free $\approx$ 15 lizards/hour; mongoose-present $\approx$ 3 lizards/hour). At every habitat type, the mongoose-free (solid) curve lies above the mongoose-present (dashed) curve.]

(b) Globally, islands vary in size, location, and habitat.

Based on the theory of island biogeography, **describe** the characteristics of an island with the greatest species diversity.

Question 2

2022 Set 2 ▪ Q2

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(c)(i) Island ecosystems are often threatened by invasive species, such as the mongoose populations studied in the survey.

Describe one environmental problem caused by invasive animal species.

(c)(ii) Invasive species are often pests. **Make a claim** that proposes one way to control pest species.

(c)(iii) **Justify** the solution proposed in (c)(ii) by providing an additional benefit of the solution.

Question 2

2022 Set 2 ▪ Q2

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(d)(i) Islands provide humans with many ecosystem services. However, humans may alter ecosystems when they obtain these services. Large-scale commercial sugarcane farming on the Pacific islands has led to significant ecological damage.

Identify a provisioning ecosystem service provided by primary forests.

(d)(ii) Based on the data in the graph, **explain** how replacing primary forests with sugarcane fields may have affected the number of lizards counted on the mongoose-free Pacific islands.

(d)(iii) The long-term use of monocultures in commercial sugarcane farming is one cause of the ecological damage. **Describe** one problem associated with monocultures.

Question 2

2022 Set 2 ▪ Q2

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(e) One solution to the ecological damage of monocultures is to use a form of crop rotation using legumes.

Describe an advantage of crop rotation using legumes on soil fertility.

Solution 2

(a)(i)

Mark scheme

- Clearings/Gardens — this habitat type has the greatest number of lizards in the graph.

(a)(ii)

Mark scheme

- Any one description: lizard populations are smaller on islands where mongooses are present than on mongoose-free islands; lizard populations are larger on mongoose-free islands than on islands with mongooses; the relationship between lizard numbers and mongoose population is an inverse (negative) relationship.

Solution 2

(b)

Mark scheme

- A large island located near the mainland will have the greatest species diversity — per island biogeography theory, larger area supports a larger population/lower extinction rate, and proximity to the mainland increases the immigration (colonization) rate.

Solution 2

(c)(i)

Mark scheme

- Any one environmental problem: invasive species outcompete native species for resources, causing food web disruptions/trophic cascades/habitat loss; invasive species outcompete or prey on native organisms, decreasing biodiversity/reducing native population sizes.

Solution 2

(c)(ii)

Mark scheme

- Any one claim proposing pest control: introduce biological controls (natural predators of the species) to reduce pest numbers; use chemical controls such as pesticides to kill off pests; use manual/mechanical methods to remove plant species; trap/hunt animal species and remove/kill them from the area.

Solution 2

(c)(iii)

Mark scheme

- Justification must match the solution proposed in (c)(ii): biological control, manual/mechanical removal, or trapping/hunting is justified as least likely to harm other species because the pest species can be specifically targeted, and harmful synthetic chemicals are not introduced into the environment (manual/trapping methods can also cite financial gain from selling killed pest organisms); chemical control (pesticides) is justified as a quick/efficient method to reduce/eliminate the pest species.

Solution 2

(d)(i)

Mark scheme

- Any one provisioning ecosystem service from primary forests: timber/lumber/wood; medicine; food.

Solution 2

(d)(ii)

Mark scheme

- Any one explanation: the cleared land is preferred habitat for the lizards, leading to increased lizard numbers in the sugarcane fields compared to forests; the cleared land has fewer predators, leading to increased lizard numbers in the sugarcane fields compared to forests; the cleared land has more food for the lizards, leading to increased lizard numbers in the sugarcane fields compared to forests.

Solution 2

(d)(iii)

Mark scheme

- Any one problem associated with monocultures: decreased genetic diversity of the monoculture species; decreased species diversity; increased susceptibility of the monoculture to disease/pests; depletion of nutrients from the soil; increased use of irrigation water/fertilizer/pesticide.

Solution 2

(e)

Mark scheme

- Any one advantage of crop rotation using legumes: improved nitrogen fixation in the soil; less nitrogen-based fertilizer required.

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.

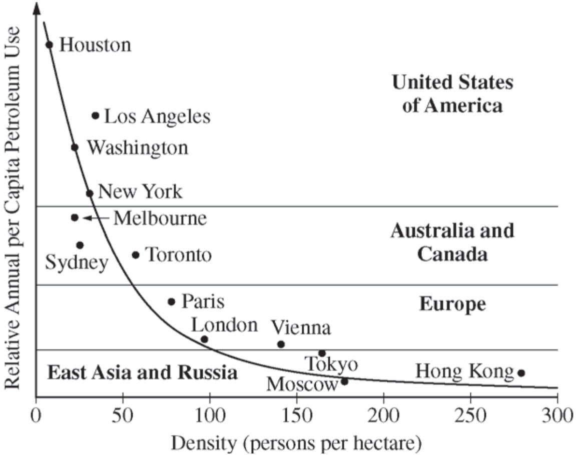
Question 4

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.