Past-paper walk-through

K-Selected and r-Selected Species ▪ 3.2

eXercise

Questions in this set

- 2025 Set 1 Q1
- 2024 Set 1 Q2
- 2023 Set 1 Q2
- 2017 Q2
- 2016 Q1

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.

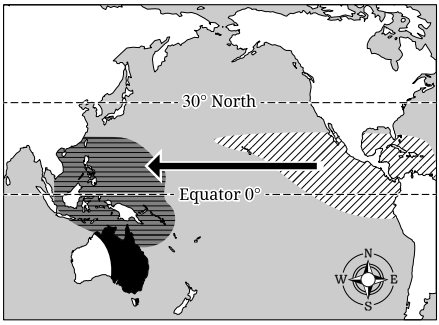
Question 1

2025 Set 1 ▪ Q1

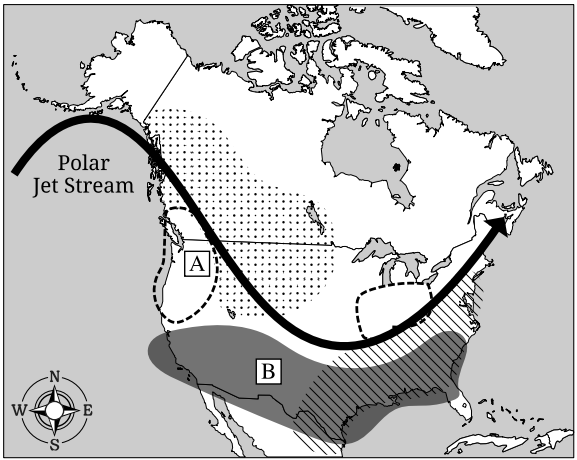
Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(a) Describe one reproductive strategy used by a K-selected species such as the chickadee.

Question 1


30° North
Equator 0°
N
W
E
S
Ocean water cooler than average
Ocean water warmer than average
Increased chance of precipitation
Stronger than normal trade winds

Question 1



Question 1

Site	Species A	Species B	Species C	Species D	Species E	Species F
Urban park	X			X	X	
Grassland	X	X	X	X		X

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(b) Based on the information provided, explain how a decrease in spider populations could affect a lower trophic level.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(c) Based on the data in Figure 1, identify the number of spiders per sample at 25% nonnative plants.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(d) Based on the data in Figure 1, describe the trend in the number of insects per sample in relation to the percentage of nonnative plants.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(e) Scientists hypothesized that the population of chickadees would be stable or growing with fewer than 25% nonnative plants. Describe one way that the data in Figure 2 support this hypothesis.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(f) Insect biodiversity is important to maintain ecosystem health. A group of students was interested in learning about factors that affect ant biodiversity. They located two study sites near their school: a frequently mowed urban park and an unmowed grassland. The students used traps designed to collect ants. They loaded 10 of these traps with the same food and placed them randomly at different locations within each site. Students collected the traps after 24 hours and counted the number of different ant species in each trap to determine species richness.

(f)(i) Identify a likely scientific question for the students' investigation of ant diversity.

(f)(ii) Identify the dependent variable in the students' investigation.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(g) The data from the student investigation of ant diversity are shown in the following table. An "X" in the table indicates that the species was present at that site.

Ant Species Present in an Urban Park and Unmowed Grassland

Site	**Species A**	**Species B**	**Species C**	**Species D**	**Species E**	**Species F**
Urban park	X			X	X	
Grassland	X	X	X	X		X

Question 1

(g)(i) Explain why the ant community of the unmowed grassland would be more likely to recover from a disturbance, such as a flood or fire, than the ant community in the mowed urban park would.

(g)(ii) Explain how the results of the investigation could have been altered if students had measured ant biodiversity at a paved playground rather than in the grassland.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(h) Habitat fragmentation has impacts on a variety of species. Paved roads can lead to habitat fragmentation.

Describe one effect that a paved road in a forest can have on animal species such as deer or bears.

Solution 1

(a)

Mark scheme

- Describe one reproductive strategy of a K-selected species (e.g., chickadee). Any one of: provides considerable parental care for offspring; has few offspring; parents expend significant energy per offspring; individuals reproduce more than once in their lifetime (iteroparity); has a long gestation period/reaches reproductive maturity later.

Solution 1

(b)

Mark scheme

- Explain how a decrease in spider populations affects a lower trophic level: insects/insect populations would increase because they are no longer being preyed on/eaten as much by spiders; consequently plant populations would decrease because more insects are now eating the plants (a trophic cascade down through insects to plants).

Solution 1

(c)

Mark scheme

- From Figure 1, the number of spiders per sample at 25% nonnative plants is 2.0 (accept 2).

Solution 1

(d)

Mark scheme

- Trend in Figure 1: as the percentage of nonnative plants increases, the number of insects per sample decreases (equivalently, as nonnative plant percentage decreases, insects increase) — an inverse/negative relationship between nonnative plant percentage and insect abundance.

Solution 1

(e)

Mark scheme

- One way Figure 2 supports the hypothesis that chickadee populations are stable or growing below 25% nonnative plants: below this threshold, the population growth rate shown is at or above replacement level (positive growth), meaning enough reproduction is occurring to replace or grow the population.

Solution 1

(f)

Mark scheme

- This is background/stem text introducing the student investigation of ant biodiversity (10 baited traps placed randomly at a frequently mowed urban park and an unmowed grassland, collected after 24 hours, species counted). It is context for parts (i) and (ii) and carries no scoring point of its own.

Solution 1

(f)(i)

Mark scheme

- A likely scientific question for the investigation: "Does the number of species/species richness/biodiversity differ between an urban park and a grassland?" or "Does mowing affect the number of species/species richness/biodiversity?"

Solution 1

(f)(ii)

Mark scheme

- The dependent variable is the number of ant species / ant species richness / the presence-absence of different ant species observed at each site.

Solution 1

(g)

Mark scheme

- This presents the data table of ant species present (X) at the urban park vs. the unmowed grassland (species A-F). It is context for parts (i) and (ii) and carries no scoring point of its own.

Solution 1

(g)(i)

Mark scheme

- The unmowed grassland's ant community would more likely recover from a disturbance because, with a larger number of species, the grassland is more likely to have some species/individuals with adaptations that allow them to survive the disturbance; the grassland is more diverse, so the loss of any one species is less likely to cause collapse of the whole community/ecosystem.

Solution 1

(g)(ii)

Mark scheme

- If biodiversity had been measured at a paved playground instead of the grassland, the playground would show fewer species than the grassland/urban park, because the paved area is not suitable habitat for many ant species, and/or because humans could trample the ants/ant habitat there.

Solution 1

(h)

Mark scheme

- One effect of a paved road through a forest on animals such as deer or bears: animals can be hit by cars when trying to cross the road while hunting/migrating (roadkill); fragmentation can isolate individuals and reduce genetic diversity; noise pollution can damage hearing, cause stress, or mask sounds used to communicate/hunt; the road/noise can alter migratory routes or prevent movement to access resources; species that thrive in edge habitats might increase. Any one of these earns the point.

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).

Global Warming Potential and Land Use from Animal Protein Production

[Figure 1: bar graph titled "Figure 1". Y-axis "Global Warming Potential (kg CO_2-eq.)" from 0 to 140 in increments of 20. X-axis "Production of 1 kg of Animal Protein" with four bars: Mealworms (10), Chicken (27), Pork (37), Beef (120).]

Question 2

(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

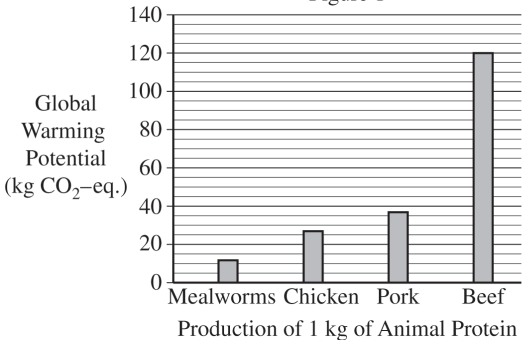
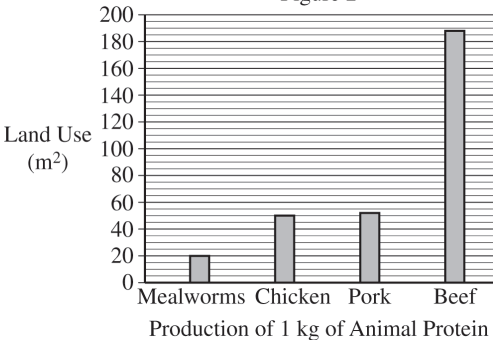


Figure 2



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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

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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

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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 → 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 → 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

2023 Set 1 ▪ Q2

The diagram shows the movement of one adult manatee over a 12-hour period across an active shipping channel during the winter. Manatees are large, aquatic, herbivorous mammals that primarily eat seagrass. Manatees can travel several miles to graze. Manatees mature slowly, have low biotic potential, and inhabit warm coastal waters. They cannot survive in water below $20°C$ for extended periods of time.

Satellite Track and Water Temperature Log of the Movement of One Adult Manatee Over a 12-Hour Period

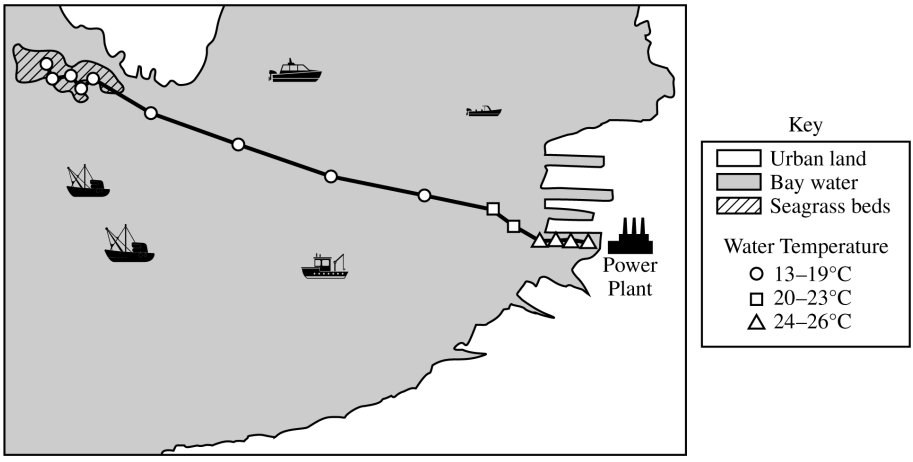
[Map diagram of a bay/river channel showing a coastline with urban land at upper left near a cluster of small circles (13-19°C markers) close to shore, and hatched "Seagrass beds" also near that shore. A black line with a series of point markers runs from the seagrass-bed/urban-land area near the top-left, diagonally down and to the right across open bay water, passing several boats (fishing boats and small craft scattered across

Question 2

the bay), and ending at the lower right near a "Power Plant" (with smokestack icon) on the opposite shore. The markers along this track are open circles (13-19°C) for most of the track's length across the open bay, changing to open squares (20-23°C) near the shore closer to the power plant, and open triangles (24-26°C) immediately adjacent to the power plant outflow. Key: Urban land = open/white box; Bay water = gray shaded box; Seagrass beds = diagonal-hatched box. Water Temperature legend: circle = 13-19°C, square = 20-23°C, triangle = 24-26°C.]

(a) Based on the information in the diagram, identify the temperature range of the water through which the majority of the adult manatee's daily movement occurs.

Question 2


Power
Plant
Key
Urban land
Bay water
Seagrass beds
Water Temperature
13–19°C
20–23°C
24–26°C

Question 2

2023 Set 1 ▪ Q2

The diagram shows the movement of one adult manatee over a 12-hour period across an active shipping channel during the winter. Manatees are large, aquatic, herbivorous mammals that primarily eat seagrass. Manatees can travel several miles to graze. Manatees mature slowly, have low biotic potential, and inhabit warm coastal waters. They cannot survive in water below 20°C for extended periods of time.

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Question 2

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(b) Large groups of manatees are often observed in shallow waters near the waste water released by the electrical power plant during the winter. Based on the information in the diagram, identify a characteristic of the power plant waste water that would attract the manatees.

Question 2

2023 Set 1 ▪ Q2

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(c) Based on the information in the diagram, describe a potential negative impact of the waste water released by the power plant on other aquatic species.

Question 2

2023 Set 1 ▪ Q2

The diagram shows the movement of one adult manatee over a 12-hour period across an active shipping channel during the winter. Manatees are large, aquatic, herbivorous mammals that primarily eat seagrass. Manatees can travel several miles to graze. Manatees mature slowly, have low biotic potential, and inhabit warm coastal waters. They cannot survive in water below 20°C for extended periods of time.

Satellite Track and Water Temperature Log of the Movement of One Adult Manatee Over a 12-Hour Period

[Map diagram of a bay/river channel showing a coastline with urban land at upper left near a cluster of small circles (13-19°C markers) close to shore, and hatched "Seagrass beds" also near that shore. A black line with a series of point markers runs from the seagrass-bed/urban-land area near the top-left, diagonally down and to the right across open bay water, passing several boats (fishing boats and small craft scattered across the bay), and ending at the lower right

Question 2

near a "Power Plant" (with smokestack icon) on the opposite shore. The markers along this track are open circles (13-19°C) for most of the track's length across the open bay, changing to open squares (20-23°C) near the shore closer to the power plant, and open triangles (24-26°C) immediately adjacent to the power plant outflow. Key: Urban land = open/white box; Bay water = gray shaded box; Seagrass beds = diagonal-hatched box. Water Temperature legend: circle = 13-19°C, square = 20-23°C, triangle = 24-26°C.]

(d) Seagrass beds have declined significantly over the last several years. In 2021 manatee mortality was three times higher than the previous five-year average.

(d)(i) Describe a characteristic of the manatees that increases their vulnerability to the recent decline of seagrasses.

(d)(ii) Describe the change in energy flow through the trophic levels that occurs when there is a significant loss of seagrasses.

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(e) Research has shown increased nutrient and sediment runoff can cause seagrass beds to decline.

(e)(i) Propose a solution to reduce nutrient or sediment pollution in an estuary that is surrounded by urban development.

(e)(ii) Justify the solution proposed in part (e)(i) by providing an additional advantage of reduced nutrients in an estuary, other than one related to manatees.

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(f) Urban areas have a heavy dependence on automobiles and often experience photochemical smog.

Describe how summertime weather conditions can increase the frequency of photochemical smog.

Question 2

2023 Set 1 ▪ Q2

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(g) Identify one ecological problem that results from exposure to photochemical smog.

Question 2

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(h) A potential solution to reduce photochemical smog in urban areas with high automobile traffic is to replace gasoline-powered cars with cars powered by hydrogen fuel cells.

Describe a potential disadvantage of using hydrogen fuel cells to power automobiles.

Solution 2

(a)

Mark scheme

- 13-19 degrees C, based on the temperature range through which the majority of adult manatee daily movement occurs in the diagram.

Solution 2

(b)

Mark scheme

- The waste water is warm (approximately 24-26 degrees C), which is why manatees are attracted to it in winter.

Solution 2

(c)

Mark scheme

- Any one of: warming of the water near the outfall reduces the dissolved oxygen available for aquatic organisms to use/breathe; the warming could impact the survival/health of species with a range of tolerance for the original (lower) water temperature; or the warming could alter/affect the timing of reproductive cycles for aquatic species.

Solution 2

(d)

Mark scheme

- This line is introductory/context text (seagrass decline and the 2021 manatee mortality spike) setting up parts (d)(i) and (d)(ii) below; it carries no points of its own – see 2di and 2dii.

Solution 2

(d)(i)

Mark scheme

- Any one of: manatees are herbivores/eat seagrass, so they would have less food and could starve; they require a lot of energy to survive, so a reduced food supply threatens them; they inhabit warm water, so they would need to travel farther to colder waters to find remaining seagrass/food; or they have a low reproductive/maturation rate, so they would take longer to recover from the loss of their food source.

Solution 2

(d)(ii)

Mark scheme

- Less energy flows to/is available for organisms at higher trophic levels, because less energy from the Sun is captured/stored by producers (seagrass) once seagrass is significantly lost.

Solution 2

(e)

Mark scheme

- This line is introductory/context text (nutrient and sediment runoff causing seagrass decline) setting up parts (e)(i) and (e)(ii) below; it carries no points of its own – see 2ei and 2eii.

Solution 2

(e)(i)

Mark scheme

- Any one solution: replace existing pavement with permeable pavement; add vegetation (e.g., a riparian buffer) where it will intercept runoff; reduce fertilizer use in the area; install barriers/construct fences where they will intercept runoff; or improve wastewater treatment plants in the area.

Solution 2

(e)(ii)

Mark scheme

- Any one additional advantage (not related to manatees): reduces eutrophication; increases biodiversity/species richness; improves water clarity; increases ecotourism; reduces the cost of water treatment; or increases profits for commercial fishermen.

Solution 2

(f)

Mark scheme

- Any one of: sunlight is more intense/there is more sunlight in summer, so more primary pollutants (nitrogen oxides/NOx) react in sunlight; summertime temperatures are warmer than other seasons, and chemical reactions occur more quickly at warmer temperatures; or trees release more VOCs in summer, leading to more reactions that form photochemical smog.

Solution 2

(g)

Mark scheme

- Any one ecological problem: causes respiratory problems/eye irritation in animals; reduces photosynthesis; slows/inhibits/stunts plant growth; or increases the susceptibility of plants to pests and disease.

Solution 2

(h)

Mark scheme

- Any one disadvantage: high cost to manufacture hydrogen-fuel-cell automobiles; obtaining hydrogen requires a lot of energy and may consume more energy than the hydrogen fuel can produce; hydrogen is explosive/flammable (may catch fire); there is a lack of infrastructure (such as fueling stations) for hydrogen fuel; or hydrogen must be obtained by separating it from natural gas or water (often using fossil fuels).

Question 2

2017 ▪ Q2

Populations of large terrestrial animals, such as African elephants and snow leopards, are in decline around the world. Many of these large animals are now on the verge of extinction.

ESTIMATED AFRICAN ELEPHANT POPULATION ON THE AFRICAN CONTINENT

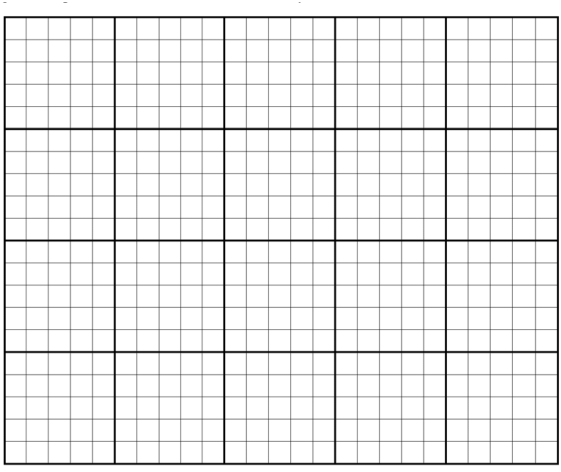
Year	Population
1970	2,000,000
1980	1,300,000
1990	600,000
1995	550,000
2000	400,000
2005	550,000
2010	650,000
2015	600,000

Question 2

(a) Using the data provided in the table above, plot the elephant population data as points on the grid below, placing the independent variable on the x-axis. Clearly label the axes.

[Blank grid for plotting; a large graph-paper grid divided into a 4×4 arrangement of bold-outlined blocks, each subdivided into finer squares, with no axes, labels, or values printed — intended for the student to draw and label the axes and plot the points from the table above.]

Question 2



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