Past-paper walk-through

Ocean Warming ▪ 9.6

eXercise

Questions in this set

- 2026 Q1
- 2026 Q2
- 2019 Q3
- 2018 Q3

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

2026 ▪ Q1

The following information applies to parts A, B, C, D, and E.

Climate change can affect both terrestrial and marine organisms. Researchers studying the effect of climate change on bird distribution mapped elevation zones at which five bird species lived within a tropical mountain range. Birds are distributed in part according to climate-related adaptations. Researchers modeled where the birds would most likely live in the future based on climate change predictions.

The results of this study are shown in the following diagram. Each unique shape in the diagram represents a different bird species, labeled A through E. Current distribution is shown on the left side of the figure, and predicted future distribution is shown on the right.

Bird Species Distribution

Question 1

[Diagram: a pyramid-shaped chart titled “Bird Species Distribution,” split into a “Current Distribution” half (left) and “Predicted Future Distribution” half (right), divided by a vertical center line. The pyramid is divided into four horizontal elevation bands, from top (narrowest) to bottom (widest): “High Elevations,” “Mid-High Elevations,” “Mid-Low Elevations,” and “Low Elevations,” separated by dashed lines. Each band shows bird-shape icons above the letters A, B, C, D, E (Current side) and A, B, C, D, E (Predicted Future side), indicating which species is present at that elevation. A legend defines a black bird silhouette = “Species present at elevation” and a gray bird silhouette = “Extinct species.”
Current Distribution:

- High Elevations: Species A and Species C present.
- Mid-High Elevations: Species A present.

Question 1

- Mid-Low Elevations: Species B and Species D present.
- Low Elevations: Species B, Species C, Species D, and Species E present.

Predicted Future Distribution:

- High Elevations: Species A present; Species E shown extinct (gray icon).
- Mid-High Elevations: Species B and Species D present.
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Question 1

The following information applies to parts F, G, and H.
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- Tank 1: 27°C and no sediment
- Tank 2: 32°C and no sediment

Question 1

- Tank 3: 37°C and no sediment

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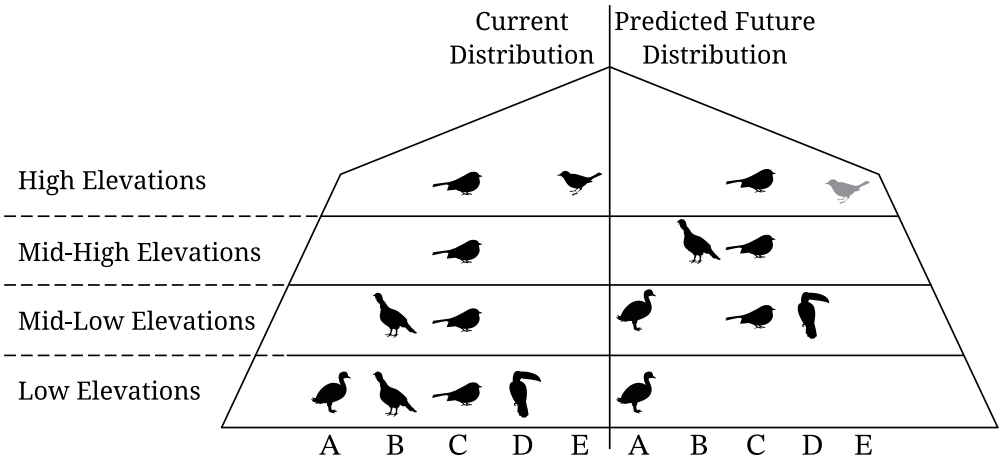
- Tank 1: 27°C and no sediment
- Tank 2: 27°C and moderate sediment
- Tank 3: 27°C and high sediment

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

(a) Based on the information in the diagram, **identify** the elevation zone that has the highest species richness for the current distribution.

Question 1


Current Distribution
Predicted Future Distribution
High Elevations
Mid-High Elevations
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A B C D E
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Question 1

2026 ▪ Q1

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Question 1

- Mid-High Elevations: Species B and Species D present.
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Question 1

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

(b) Describe a climate condition at high elevations that is different than it is at low elevations.

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(c) A predator at low elevations currently feeds on Species C and D. Based on the information in the diagram, **describe** what could happen to the predator species in the future in response to the predicted changes in the prey community.

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(d) Species C is considered a generalist, while Species E is considered a specialist. **Explain** why Species C and E are predicted to respond differently to climate change.

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(e) Based on the information in the diagram, **explain** why the bird community at low elevations in the future would be less likely to recover from natural disruptions than the current low-elevation bird community.

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

(f) Identify the independent variable in Experiment 1.

Question 1

2026 ▪ Q1

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(g) Identify a likely scientific question for Experiment 1.

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(h) In Experiment 2 the temperature of the tanks was held constant, while the amount of sediment was varied. **Explain** how this modification could affect the results of this experiment.

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(i) Changes in climate also affect Arctic ecosystems. One impact of climate change is the loss of ice and snow in polar regions. **Describe** a positive feedback loop that results from the loss of ice and snow in polar regions.

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Bird Species Distribution

[Diagram: a pyramid-shaped chart titled "Bird Species Distribution," split into a "Current Distribution" half (left) and "Predicted Future Distribution" half (right), divided by a vertical center line. The pyramid is divided into four horizontal elevation bands, from top (narrowest)

Question 1

to bottom (widest): “High Elevations,” “Mid-High Elevations,” “Mid-Low Elevations,” and “Low Elevations,” separated by dashed lines. Each band shows bird-shape icons above the letters A, B, C, D, E (Current side) and A, B, C, D, E (Predicted Future side), indicating which species is present at that elevation. A legend defines a black bird silhouette = “Species present at elevation” and a gray bird silhouette = “Extinct species.”
Current Distribution:

- High Elevations: Species A and Species C present.
- Mid-High Elevations: Species A present.
- Mid-Low Elevations: Species B and Species D present.
- Low Elevations: Species B, Species C, Species D, and Species E present.

Predicted Future Distribution:

- High Elevations: Species A present; Species E shown extinct (gray icon).

Question 1

- Mid-High Elevations: Species B and Species D present.
- Mid-Low Elevations: Species A, Species C, and Species D present.
- Low Elevations: Species A present.]

The following information applies to parts F, G, and H.
Some organisms such as birds can move in response to environmental changes, while other organisms such as corals cannot. Researchers studying the effect of climate change on marine organisms conducted two experiments involving photosynthetic algae that have a symbiotic relationship with corals.
In Experiment 1, the researchers placed photosynthetic algal colonies living in corals in three different saltwater tanks. The temperature of Tank 1 was set to 27°C, the average temperature at which most corals live. Water circulation in each tank mimicked natural ocean currents. After 30 days, the researchers counted the number of bleached corals. The tank setups are shown in the following list.

Question 1

- Tank 1: 27°C and no sediment
- Tank 2: 32°C and no sediment
- Tank 3: 37°C and no sediment

In Experiment 2, the researchers used the same photosynthetic algae living in corals but modified the conditions of the tanks as shown in the following list. Water circulation kept the sediment in the tanks suspended. After 30 days, the researchers counted the number of bleached corals.

- Tank 1: 27°C and no sediment
- Tank 2: 27°C and moderate sediment
- Tank 3: 27°C and high sediment

Question 1

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

(j) Describe one problem that Arctic species, such as polar bears or ringed seals, face because of warming in polar regions.

Question 2

2026 ▪ Q2

The following information applies to parts A, B, C, D, E, F, and G.
The following graph shows the number of quadrillion British thermal units (BTUs) that were consumed in the United States using five different energy sources from 1950 to 2020.

Energy Consumption by Source in the United States, 1950-2020

[Line graph titled "Energy Consumption by Source in the United States, 1950-2020"; x-axis "Year" from 1950 to 2020 in increments of 10; y-axis "Energy Consumption (quadrillion BTU)" from 0 to 50 in increments of 10. Five lines, per the legend: Coal (thin solid line), Natural gas (dashed line), Petroleum (thick dotted line), Nuclear (thick solid line), Renewables (thin dotted line).

Question 2

- Petroleum (thick dotted): starts around 14 in 1950, rises steadily to a peak near 38 around 1978, dips to about 30 around 1983, rises again with fluctuations to a peak near 40 around 2005, declines to about 34 around 2012, rises slightly then drops sharply to about 33 by 2020.
- Natural gas (dashed): starts around 6 in 1950, rises to about 22 by 1970, dips slightly through the 1970s-80s to about 18, rises again through the 1990s-2000s to about 23 around 2000-2010, then rises sharply after 2010 to about 32 by 2020.
- Coal (thin solid): starts around 13 in 1950, dips to about 9 by 1960, rises gradually with fluctuations to about 23 by the early 2000s, stays around 20-22 through the 2000s, then declines sharply after 2010 to about 9 by 2020.

Question 2

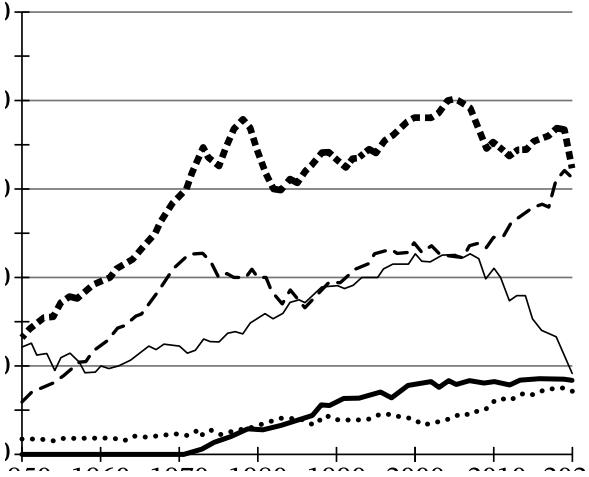
- Nuclear (thick solid): near 0 from 1950 to about 1970, rises steadily from the 1970s to about 8 by 2000, continues rising slightly to about 8-9 through 2010-2020.
- Renewables (thin dotted): near 0-1 from 1950 to 1970, rises slowly with fluctuations to about 6 by 2000, rises gradually to about 8-9 by 2020, converging with Nuclear near the end.]

The following information applies to parts H and I.
Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

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

(a) Identify one renewable energy source that is used to generate electricity.

Question 2



Question 2

2026 ▪ Q2

The following information applies to parts A, B, C, D, E, F, and G.
The following graph shows the number of quadrillion British thermal units (BTUs) that were consumed in the United States using five different energy sources from 1950 to 2020.
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[Line graph titled "Energy Consumption by Source in the United States, 1950-2020"; x-axis "Year" from 1950 to 2020 in increments of 10; y-axis "Energy Consumption (quadrillion BTU)" from 0 to 50 in increments of 10. Five lines, per the legend: Coal (thin solid line), Natural gas (dashed line), Petroleum (thick dotted line), Nuclear (thick solid line), Renewables (thin dotted line).

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Question 2

The following information applies to parts H and I.
Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

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

(b) Based on the data in the graph, **identify** the energy source that had the highest consumption in 2010.

Question 2

2026 ▪ Q2

The following information applies to parts A, B, C, D, E, F, and G.
The following graph shows the number of quadrillion British thermal units (BTUs) that were consumed in the United States using five different energy sources from 1950 to 2020.
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[Line graph titled "Energy Consumption by Source in the United States, 1950-2020"; x-axis "Year" from 1950 to 2020 in increments of 10; y-axis "Energy Consumption (quadrillion BTU)" from 0 to 50 in increments of 10. Five lines, per the legend: Coal (thin solid line), Natural gas (dashed line), Petroleum (thick dotted line), Nuclear (thick solid line), Renewables (thin dotted line).

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Question 2

The following information applies to parts H and I.
Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

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

(c) Based on the data in the graph, **describe** the pattern in the energy consumption from coal in the United States from 1960 to 2020.

Question 2

2026 ▪ Q2

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The following graph shows the number of quadrillion British thermal units (BTUs) that were consumed in the United States using five different energy sources from 1950 to 2020.
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Question 2

The following information applies to parts H and I.
Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

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

(d) Based on the data in the graph and your knowledge of energy consumption, **explain** one likely reason why the use of coal for energy changed between 2010 and 2020.

Question 2

2026 ▪ Q2

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Question 2

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Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

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

(e) Explain how fossil fuels are used to generate electricity.

Question 2

2026 ▪ Q2

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Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

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

(f) In addition to fossil fuels, nuclear power can be used to generate electricity.
Identify one negative impact associated with nuclear energy.

Question 2

2026 ▪ Q2

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Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

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

(g) Fossil fuel combustion leads to ocean warming. **Describe** one environmental problem other than coral bleaching that is associated with warming oceans.

Question 2

2026 ▪ Q2

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The following information applies to parts H and I.
Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

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

(h) Explain how an increase in nutrients, such as nitrates and phosphates, can negatively affect an aquatic ecosystem.

Question 2

2026 ▪ Q2

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Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

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

(ii) Propose a realistic solution that would reduce nutrient pollution of waterways, while still allowing cultivation of crops.

(iii) Justify the solution proposed in part I (i) by explaining one potential advantage other than reducing nutrient runoff.

Question 3

2019 ▪ Q3

The graph shows measurements of atmospheric levels of carbon dioxide (CO_2) at Mauna Loa Observatory, Hawaii, and the measurements of pH levels in the ocean nearby at Station ALOHA. Measurements of pH began in 1992.

ATMOSPHERIC CARBON DIOXIDE AT MAUNA LOA AND OCEANIC pH AT STATION ALOHA, HAWAII

[Dual-axis line graph, x-axis "Year" from 1965 to 2015. Left y-axis "CO_2 (ppm)" from 275 to 400 in steps of 25 (275, 300, 325, 350, 375, 400). Right y-axis "pH" from 8.00 to 8.37 in steps of 0.07 (8.00, 8.08, 8.16, 8.23, 8.30, 8.37). Solid line = Mauna Loa Atmospheric CO_2 (ppm): a steadily rising, seasonally oscillating (sawtooth) curve starting at about 315 ppm in the early 1960s and rising to about 400 ppm by 2015. Dashed line = Station ALOHA Ocean pH: begins around 1992 near pH 8.11, oscillates with high-frequency noise, and shows an overall gradual downward trend to about pH

Question 3

8.07 by 2015 (with a fitted trend line sloping downward from left to right over that span).]

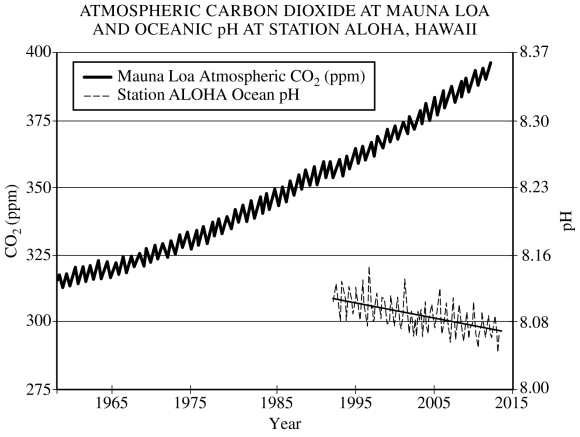
(a)(i) Use the graph above to answer the following questions.

Determine the concentration of CO_2 (in ppm) recorded at Mauna Loa in 2005.

(a)(ii) Determine the pH recorded at Station ALOHA in 2005.

Question 3

began in 1992.



Question 3

2019 ▪ Q3

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Question 3

downward trend to about pH 8.07 by 2015 (with a fitted trend line sloping downward from left to right over that span).]

(b)(i) Changes in atmospheric carbon dioxide affect Earth's oceans.
Predict the effect of increased concentration of atmospheric CO_2 on the concentration of CO_2 in the ocean.

(b)(ii) Based on the data, identify the relationship between the concentration of atmospheric CO_2 and the pH of ocean water.

(b)(iii) Provide the complete chemical equation that represents the reaction between oceanic carbon dioxide (CO_2) and water (H_2O).

(b)(iv) Identify the specific environmental problem that directly results from the decrease in pH of Earth's oceans.

Question 3

2019 ▪ Q3

The graph shows measurements of atmospheric levels of carbon dioxide (CO_2) at Mauna Loa Observatory, Hawaii, and the measurements of pH levels in the ocean nearby at Station ALOHA. Measurements of pH began in 1992.

ATMOSPHERIC CARBON DIOXIDE AT MAUNA LOA AND OCEANIC pH AT STATION ALOHA, HAWAII

[Dual-axis line graph, x-axis "Year" from 1965 to 2015. Left y-axis "CO_2 (ppm)" from 275 to 400 in steps of 25 (275, 300, 325, 350, 375, 400). Right y-axis "pH" from 8.00 to 8.37 in steps of 0.07 (8.00, 8.08, 8.16, 8.23, 8.30, 8.37). Solid line = Mauna Loa Atmospheric CO_2 (ppm): a steadily rising, seasonally oscillating (sawtooth) curve starting at about 315 ppm in the early 1960s and rising to about 400 ppm by 2015. Dashed line = Station ALOHA Ocean pH: begins around 1992 near pH 8.11, oscillates with high-frequency noise, and shows an overall gradual

Question 3

downward trend to about pH 8.07 by 2015 (with a fitted trend line sloping downward from left to right over that span).]

(c)(i) Changes in pH in the world's oceans pose a risk to many marine organisms. Explain why certain organisms, in particular those with calcium carbonate shells or exoskeletons, are threatened by the decreasing pH levels measured in seawater.

(c)(ii) Other than threats posed by decreasing pH, identify an additional anthropogenic threat to the world's coral reef ecosystems and describe how the threat damages the coral reefs and coral reef ecosystems.

Solution 3

(a)(i)

Mark scheme

- CO_2 concentration at Mauna Loa in 2005: 380 ppm (accept 375–385 ppm, i.e. ± 5 ppm read from the graph).

(a)(ii)

Mark scheme

- pH recorded at Station ALOHA in 2005: 8.08 (accept 8.06–8.10, i.e. ± 0.02 read from the graph).

Solution 3

(b)(i)

Mark scheme

- Predicted effect of increased atmospheric CO_2 on oceanic CO_2: oceanic (dissolved) CO_2 will increase. Full credit for stating that oceanic CO_2 increases as atmospheric CO_2 increases.

Solution 3

(b)(ii)

Mark scheme

- Relationship between atmospheric CO_2 and ocean pH: as atmospheric CO_2 increases, pH decreases (equivalently: as more CO_2 dissolves in the water it becomes more acidic/less alkaline; or H_3O^+/H^+ ion concentration increases as atmospheric CO_2 increases). Full credit for correctly identifying the inverse relationship.

Solution 3

(b)(iii)

Mark scheme

- Balanced chemical equation for the reaction between oceanic CO_2 and water — any one of: $CO_2 + H_2O \rightarrow H_2CO_3$ (carbon dioxide plus water produces carbonic acid); $CO_2 + H_2O \rightarrow H^+ + HCO_3^-$ (produces one hydrogen ion and one bicarbonate ion); $CO_2 + H_2O \rightarrow 2H^+ + CO_3^{2-}$ (produces two hydrogen ions and one carbonate ion). Full credit for any one correctly balanced equation.

Solution 3

(b)(iv)

Mark scheme

- Specific environmental problem resulting directly from the decrease in ocean pH: Ocean Acidification.

Solution 3

(c)(i) Mark scheme

- 2 points — 1 point for explaining the chemical impact of decreased pH on shell/coral formation, and 1 point for describing the resulting impact on organism survival. Chemical impact examples: a decrease in pH could cause shells/exoskeletons to dissolve; prevent the growth of new coral/shells; prevent renewal/maintenance of existing coral/shells. Survival impact examples: organisms such as mollusks and coral would be threatened with reduced fitness/decreased number of offspring; increased predation risk; increased threat of disease. Both a valid chemical-impact idea and a valid survival-impact idea are needed for full 2 points; either alone earns 1 point.

Solution 3

(c)(ii) Mark scheme

- 2 points — 1 point for identifying an anthropogenic threat to coral reefs other than decreasing pH, 1 point for describing how it damages coral reefs/reef ecosystems. Acceptable paired examples: Increased ocean temperature → coral bleaching (loss of the algal symbiont), reduction of dissolved oxygen concentration; Recreational activities (watercraft, scuba, snorkeling, swimming, etc.) → physical damage to/destruction of coral reefs; Fishing practices (bottom trawling, dynamite fishing, overfishing, etc.) → physical damage to/destruction of coral reefs, removal of key species disrupts the food web/causes a trophic cascade; Nutrient pollution (agricultural runoff, wastewater treatment plants) → cultural eutrophication and eventual decrease in dissolved oxygen levels, excessive algal

Solution 3

growth reduces light penetration; Sediment pollution (logging operations, mining, etc.) $\rightarrow$ increased turbidity/reduction in light penetration, deposited sediments cover/smother coral reefs; Chemical pollution (oil spills, pesticide runoff, sunscreen, etc.) $\rightarrow$ disruption of reproduction and growth cycles, disruption of metabolic processes, endocrine disruption/DNA damage, reduction in light penetration; Plastic/solid waste pollution $\rightarrow$ physical damage to/destruction of members of the coral reef ecosystem, reduction in light penetration; Introduction of invasive species (lionfish/turkey fish, Philippine mantis shrimp, etc.) $\rightarrow$ invasive species can outcompete native species. Award 1 point for a valid threat, 1 point for a correctly linked description of damage.

Question 3

2018 ▪ Q3

An Arctic food web includes the following organisms.

[Food-web diagram showing organisms connected by arrows pointing from prey to predator (from what is eaten to what eats it), labeled: "Orca", "Polar Bear", "Arctic Cod", "Ringed Seal", "Krill (zooplankton)", "Diatom (phytoplankton)". Arrows: Diatom (phytoplankton) → Krill (zooplankton); Diatom (phytoplankton) → Ringed Seal; Krill (zooplankton) → Arctic Cod; Arctic Cod → Orca; Arctic Cod → Polar Bear; Ringed Seal → Polar Bear; Ringed Seal → Orca; Polar Bear → Orca. Note: Figures not drawn to scale.]

(a)(i) Refer to the food web above to complete the following table.

Question 3

	Organism from Arctic food web
(i) Identify a primary producer	
(ii) Identify a primary consumer	
(iii) Identify a secondary consumer	

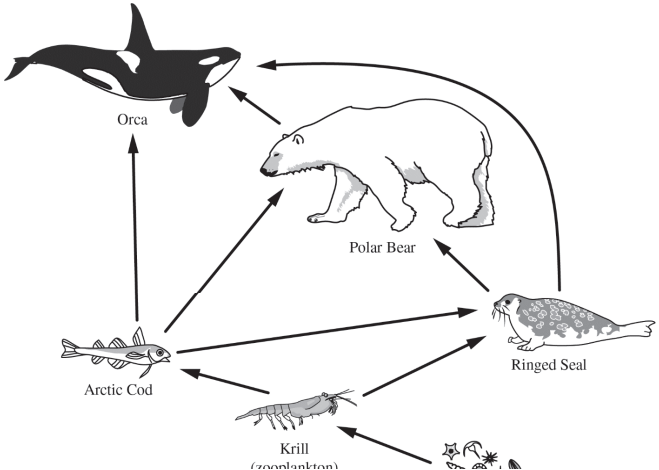
Identify a primary producer.

(a)(ii) Identify a primary consumer.

Question 3

(a)(iii) Identify a secondary consumer.

Question 3



Question 3

(zooplankton)

Diatom
(phytoplankton)

Note: Figures not drawn to scale.

Question 3

	Organism from Arctic food web
(i) **Identify** a primary producer	
(ii) **Identify** a primary consumer	
(iii) **Identify** a secondary consumer	

Question 3

2018 ▪ Q3

An Arctic food web includes the following organisms.

[Food-web diagram showing organisms connected by arrows pointing from prey to predator (from what is eaten to what eats it), labeled: "Orca", "Polar Bear", "Arctic Cod", "Ringed Seal", "Krill (zooplankton)", "Diatom (phytoplankton)". Arrows: Diatom (phytoplankton) → Krill (zooplankton); Diatom (phytoplankton) → Ringed Seal; Krill (zooplankton) → Arctic Cod; Arctic Cod → Orca; Arctic Cod → Polar Bear; Ringed Seal → Polar Bear; Ringed Seal → Orca; Polar Bear → Orca. Note: Figures not drawn to scale.]

(b) Other than showing which organisms are consumed by other organisms, describe what is indicated by the direction of the arrows in the diagram.

Question 3

2018 ▪ Q3

An Arctic food web includes the following organisms.

[Food-web diagram showing organisms connected by arrows pointing from prey to predator (from what is eaten to what eats it), labeled: “Orca”, “Polar Bear”, “Arctic Cod”, “Ringed Seal”, “Krill (zooplankton)”, “Diatom (phytoplankton)”. Arrows: Diatom (phytoplankton) → Krill (zooplankton); Diatom (phytoplankton) → Ringed Seal; Krill (zooplankton) → Arctic Cod; Arctic Cod → Orca; Arctic Cod → Polar Bear; Ringed Seal → Polar Bear; Ringed Seal → Orca; Polar Bear → Orca. Note: Figures not drawn to scale.]

(c) As the amount of sea ice has decreased, larger expanses of the Arctic Ocean are now completely free of sea ice for several weeks each summer. Ringed seals, the preferred prey of polar bears, come to holes in the sea ice to breathe.

Describe how the change in sea ice habitat is affecting polar bears’ ability to hunt and feed.

Question 3

2018 ▪ Q3

An Arctic food web includes the following organisms.

[Food-web diagram showing organisms connected by arrows pointing from prey to predator (from what is eaten to what eats it), labeled: “Orca”, “Polar Bear”, “Arctic Cod”, “Ringed Seal”, “Krill (zooplankton)”, “Diatom (phytoplankton)”. Arrows: Diatom (phytoplankton) → Krill (zooplankton); Diatom (phytoplankton) → Ringed Seal; Krill (zooplankton) → Arctic Cod; Arctic Cod → Orca; Arctic Cod → Polar Bear; Ringed Seal → Polar Bear; Ringed Seal → Orca; Polar Bear → Orca. Note: Figures not drawn to scale.]

(d) Explain how melting sea ice leads to a feedback loop that increases Arctic warming.

Question 3

2018 ▪ Q3

An Arctic food web includes the following organisms.

[Food-web diagram showing organisms connected by arrows pointing from prey to predator (from what is eaten to what eats it), labeled: “Orca”, “Polar Bear”, “Arctic Cod”, “Ringed Seal”, “Krill (zooplankton)”, “Diatom (phytoplankton)”. Arrows: Diatom (phytoplankton) → Krill (zooplankton); Diatom (phytoplankton) → Ringed Seal; Krill (zooplankton) → Arctic Cod; Arctic Cod → Orca; Arctic Cod → Polar Bear; Ringed Seal → Polar Bear; Ringed Seal → Orca; Polar Bear → Orca. Note: Figures not drawn to scale.]

(e)(i) Many species, including some whales and birds, will travel thousands of kilometers during annual migrations.

Provide one reason a species may migrate a long distance.

(e)(ii) The North Atlantic right whale migrates between subtropical and polar waters annually. Nearly 50 percent of right whale deaths are due to human activities.

Question 3

Describe one commercial activity, other than whaling, that may result in the death of right whales.

(e)(iii) Describe one strategy that could reasonably be implemented to decrease right whale deaths caused by the commercial activity you described in part (ii).

Solution 3

(a)(i)

Mark scheme

- 1 point for correctly identifying a primary producer from the Arctic food web: Diatom (phytoplankton).

(a)(ii)

Mark scheme

- 1 point for correctly identifying a primary consumer from the Arctic food web: Krill (zooplankton).

Solution 3

(a)(iii)

Mark scheme

- 1 point for correctly identifying a secondary consumer from the Arctic food web: Cod or seal.

Solution 3

(b)

Mark scheme

- 1 point for a correct description of what the arrow direction indicates, other than which organisms are consumed by others. Accept: shows the flow of energy among trophic levels; OR shows the flow of matter through trophic levels.

Solution 3

(c) Mark scheme

- 1 point for a correct description of how the changing sea ice habitat affects polar bears' ability to hunt/feed. Accept any one of: decreasing area of hunting ground (fewer seal breathing holes/less ice for hauling out) makes it more difficult for polar bears to get food; increasing distance between hunting grounds means polar bears must exert more energy to swim to find food, causing physical exhaustion and less energy available for hunting; increasing physiological stress (dehydration, exhaustion, cub mortality) because polar bears are not physiologically adapted to warmer temperatures; increasing the time between successful kills means bears spend more time waiting/hunting for prey.

Solution 3

(d)

Mark scheme

- 2 points: 1 point for explaining the connection between melting ice and increased absorption of the sun's energy, and 1 point for explaining that this increased absorption leads to further ice melt (completing the positive feedback loop). Melting of sea ice leads to a decrease in albedo/reflectivity, causing water surfaces to absorb more of the sun's energy; AND this increasing absorption of the sun's energy warms the water surface further, which leads to further ice melt (completes the positive feedback loop).

Solution 3

(e)(i)

Mark scheme

- 1 point for a correct reason a species may migrate a long distance. Accept any one of: limited food/water supply leads to migration to locations with more food/water supply; food supply migrates and the species follows its prey; more hospitable climate during certain seasons; availability of mates/breeding/birthing occurs in a different location; protection of offspring from predators.

Solution 3

(e)(ii)

Mark scheme

- 1 point for a correct description of a commercial activity, other than whaling, that may result in right whale deaths. Accept any one of: fishing nets entangle whales as by-catch/fishing gear can accidentally trap whales; ships and whales use the same channels, which can increase the number of ship strikes; noise pollution from seismic surveys/sonar/engine noise can disrupt a whale's internal navigational system.

Solution 3

(e)(iii) Mark scheme

- 1 point for a correct strategy linked to the activity named in part (ii). If fishing gear/by-catch was named: require a change of fishing method (location, timing, or materials) that traps whales, to reduce the number of whales trapped in nets/gear; OR fines for discarded fishing gear so less gear is discarded, reducing whales trapped in gear. If ship strikes were named: improved navigational technology to spot whales close to ships to avoid collisions; OR increased education of ship captains/crews about whale habitat/migration routes/feeding behaviors; OR expansion of low-speed navigational zones around ports. If noise pollution was named: reduction of seismic survey activity/sonar use in coastal areas; OR installation of quieter motors to reduce/eliminate noise pollution.