KEEP ANTARCTICA COLD

GRADE LEVEL 6-8

Photo: © Espen Rekdal

KEEP ANTARCTICA COLD

GRADE LEVEL 6-8
60 minute Lesson

Standards (NGSS):

MS-ESS3-3 Earth and Human Activity

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

From the Film:

The film focuses primarily on the ramifications of climate change on the amount of sea ice and animal behavior. It brilliantly showcases how the interconnectedness of the world's systems, no matter how far away, can affect the Antarctic ecosystem. There are many things that we as human beings can do to help mitigate human influenced climate change.

Lesson Overview:

Students will take a tour of their school observing the different operations that allow their school to run efficiently. Then, they will be split into groups and challenged to redesign a part of their school to make it more energy efficient (green) using renewable energy options or smaller, cost-effective, but impactful changes. If time allows each group could be tasked with designing the entire school. Each group will have separate building and operating budgets to consider the short term and longer-term impacts of their designs.

The goal is to design, build and write up the proposed changes to their school under the guise that they would present their recommendations to their school board.

Materials:

- Green Building Activity Sheets, pp. 72-74 *(one per student)*
- Poster board
- Scissors
- Building materials: cardboard, duct tape, glue, paper, dowel rods
- Computers (at least one per group)
- Operational & building budget handout
- LEED Building Checklist:

https://www.usgbc.org/resources/checklist-leed-v4-building-design-and-construction

- News article: *"How can we make our buildings green?"*

https://www.worldgbc.org/how-can-we-make-our-buildings-green

KEEP ANTARCTICA COLD

EDUCATOR PREP:

Prior to class, assemble presenting materials like poster board and paper and divide students into groups. Print the ***World Green Building Council*** article for each student to have a copy or provide students with access on their devices at:

https://www.worldgbc.org/how-can-we-make-our-buildings-green

EDUCATOR GUIDE:

1. Inform students that today they will respond to a Request for Proposal put forth by their school board asking for ideas to redesign a part of their school to decrease its carbon footprint. Introduce them to fossil fuels, and actions that contribute to a large carbon footprint like food waste, transportation, heating and cooling, and energy needs.

2. Have students read the article from the World Green Building Council. They will use the information provided in this article to consider possible improvements to their school.

3. With this idea in mind, break the students into groups of four or five and allow them to observe a specific section of the school for 5 minutes to understand the school's current operations. Encourage them to take note of the number of lights and type, trash and recycling access, temperature of the room, and other relevant things within their selected part of the school.

4. When they return, hand out LEED building checklist and scorecard. As you go over the checklist, show the students examples of energy efficient utilities, LEED certified building recommendations as well green alternatives. If time allows, have student research this instead of providing examples.

5. Hand out the ***Green Building/Better World*** project activity sheets and walk through the process of beginning to create a proposal.

6. Let students know that since they have been provided a finite amount of money, they will need to consider the best way to maximize their budget. Now that they have completed an initial assessment, they will need to price the upgrades to see how they can get the biggest impact for their budget.

Almere, a planned city and municipality in the Netherlands, has made a huge investment in solar energy.

Photo: Shutterstock / Pavlo Glazkov

KEEP ANTARCTICA COLD

7. Have students self-identify (or assign) into one of the four roles that will be required for this project:

Finance – responsible for having the group finalize their budget for the project)

Marketing – responsible for having the group create a Flipgrid video, including a visual aid, to share their proposal

Operations – responsible for writing up the description of what they are proposing and why

Project Manager – responsible for helping the group stay on task and meet their deadline of a written and video proposal by the end of the period.

8. Provide students with about 30 minutes to be able to complete the project sheet and record their 3-5 minute pitch on Flipgrid for why their project should be funded. They have the option to create a digital or poster-board to use in their pitch as a visual aid. This can be done with poster board, chart paper, or a digital tool like ***Google Slides*** or ***PowerPoint***. They should address all of the questions on the activity sheets as part of their Flipgrid video.

9. Once all of the proposals have been submitted, have students watch other groups' proposals and answer the following questions in their notebooks:

Which of the proposals that you did not work on was most convincing? Why?

Student answers will vary, but should include an explanation for why they found the one they choose the most compelling.

How did it feel to try to balance impact with cost?

Student choices will vary, but should include a reflection of the tension between trying to design something with some impact within the restriction of a budget.

Educator Notes:

GREEN BUILDING/BETTER WORLD

The school board of your district has allocated $250,000 for you to spend on reducing the impact of your school on the environment and have put for the an RFP (Request for Proposals). In this exercise, you will begin to develop a proposal by assessing an area in the school and considering ways that it may be modified to bring it closer to LEED Standards. Once you have made your assessment, you will put together a proposal using the price list below to consider what you will do with the budget that you have been given.

Assessment of School Area

What part of the school did you choose to modify?

Why did you choose this area?

What are the opportunities in this area to reduce your school's impact on the environment?

GREEN BUILDING/BETTER WORLD

Project Budget

Use the Price List on p. 70 to create a project budget for the $250,000 that is available to spend:

Item	Location to Install	Cost

Budget Justification

In 8-10 sentences, describe why you have selected these items with which to upfit your school. How will these upgrades help to reduce your school's impact on the environment and reduce its carbon footprint?

GREEN BUILDING/BETTER WORLD

Green Building Price List

Use the Price List below to create a budget plan for the $250,000 that is available to spend:

Item	Description	Installation Location	Cost
Solar Panels	Panels that collect sunlight that can be converted to electricity.	Solar Panels	$100,000
Recycling Wastewater System	Water is cleaned and cycled back inside the building to be used in non-potable ways.	Bathroom or Kitchens	$50,000
Windmill	Wind energy is converted to electricity used in the building.	Outside	$200,000
Windows	Replace Existing Windows with Energy Efficient Windows to reduce the amount of heat leaking in during the summer or out during the winter.	Outside	$5,000 per Window
Motion Sensors for Lights	Lights turn on when people enter the room and off when they leave.	Anywhere	$500 per light
LED Bulbs	Energy efficient bulbs reduce power usage.	Anywhere	$50 per light
Electric Car Charging Station	Allow for electric cars to recharge while parked.	Outside	$75,000
Energy Efficient Air Conditioning and Heating	Temperature control that uses less energy.	Entire Building	$100,000
Recycling Options	Stations that encourage people to reduce the amount of waste by adding items to be recycled.	Cafeteria, Classrooms	$1000 Per Station
Additional Windows for More Natural Lighting	More windows create a connection to nature and reduce the need for artificial lighting.	Anywhere	$10,000 per window
Native Plants Garden	A garden designed to contain native plants that attract and support pollinators.	Outside	$1,000
Composting Food Waste System	A system to collect food waste to reuse in the garden, and reduce garbage.	Cafeteria	$ 5,000

ON THIN ICE

GRADE LEVEL 6-8

ANTARCTICA EDUCATOR GUIDE

Photo: © Espen Rekdal

ON THIN ICE

GRADE LEVEL 6-8
60 minute Lesson

Standards (NGSS):

MS-ESS3-3 Earth and Human Activity

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

From the Film:

The film explains how record high temperatures lead to glacial melt which often stimulates a change in feeding behavior for Antarctic wildlife. The film also examines the interrelation between sea ice melt, sea level rise, rising ocean temperatures and ocean acidification.

Lesson Overview:

Students will experience a lab demonstration in which they observe a color change when simulated sea water encounters excessive amounts of carbon dioxide. Following this activity, students will be introduced to the term ocean acidification and carbon dioxide emitters, both natural and human. Students will learn about the extra vulnerability of polar waters as carbon dioxide dissolves more in cold water than warm. They will test various acidic solutions on shells to learn, observe and record how the decreased pH affects invertebrate marine life.

Materials:

- Activity Sheets, p. 81, 83, 85, 87 *(one per student)*
- Lab Trays
- 4000 ml .04% Bromothymol Blue Solution
- Hydrochloric Acid (optional)
- Metal or paper straw or soda streamer with CO_2 canister
- Shells – one per group
- Stopwatches
- Class set of dustless chalk
- Class set of 4 oz. cups
- 50 ml glass beakers (3 per group, labeled 1, 2, 3)
- pH test strips (double class set)
- Vinegar
- Antacid tablets (class set)
- Cold, warm and hot water
- Thermometers (3 per table)
- Carbon Cycle video:

https://www.youtube.com/watch?v=vrDekmRbBVk

ON THIN ICE

EDUCATOR PREP:

Before class, make 4000 ml of a diluted Bromothymol blue solution. Pour 1000 ml of solution into each of two beakers or flasks. Warm one flask up to about 90 degrees Celsius and leave on the hot plate until ready to use. Warm up a second flask to 90 degrees and remove from the hot plate at the beginning of class. Leave the rest at room temperature.

Fill the student sets with about 100-150 ml of the solution in each beaker. Be sure that each student group set has a sample from each three temperature – one hot, one warm, and one room temperature.

Print out one activity sheet for each student.

EDUCATOR GUIDE:

1. Inform the students that today, they are going to be exploring the cause and subsequent effects of ocean acidification. Begin by showing this video of the Carbon Cycle from the EPA.

https://www.youtube.com/watch?v=vrDekmRbBVk.

2. Just as solids like salt and sugar can dissolve in water, so can gases. One such gas is Carbon Dioxide which is produced during respiration. Encourage students to breathe in and then breathe out. Point out as they exhale: they are breathing out CO_2. This gas is also produced when organic and carbon particles are burned. While this gas is naturally occurring, with plants both above and underwater converting the CO_2 they encounter to Oxygen, it is also emitted by the burning of fossil fuels. Prior to the industrial revolution the Earth's average CO_2 was 280 parts per million (ppm). The current global average of CO_2 according to ***climate.gov*** is 407.4 ppm. About one third of atmospheric carbon dioxide is absorbed by the ocean.

3. Let students know that today, we will explore these ideas in three ways: A demonstration of Carbon Dioxide absorption, testing how temperature affects carbon absorption, and observing how acidic ocean water affects sea life.

Below the sea ice, in the Ross sea, the water is a constant -2°C (about 28°F). The sea floor is carpeted with starfish and sea spiders the size of dinner plates. This rarely seen ecosystem is perhaps one of the most pristine left on earth.

Photo: © Espen Rekdal

ON THIN ICE

CARBON ABSORPTION DEMO

4. Explain that the dark blue solution represents ocean water with an average pH of 8.1. Instruct them to pay close attention as you add something to the water

a. Using a soda streamer and purchased CO_2

i. Insert the hose into the cup or glass and spray in carbonated water.

ii. Continue to add the water until the once dark blue solution turns a bright yellow.

b. Using a reusable straw, and your own CO_2

(You may call on a volunteer, making sure that no students share the same straw)

i. Insert the straw into the cup or glass and instruct your volunteer to blow bubbles in the water.

ii. Continue to blow bubbles until the once dark blue solution turns a bright yellow.

5. Ask the students to explain what happened using these questions:

What was put into the water?

Carbon dioxide that was exhaled out of the lungs was added to the water.

What is significant about the once dark blue, now yellow water?

The color indicates how much carbon dioxide has been dissolved into the water. The color changes as more carbon dioxide is dissolved.

6. Inform students that this water has an indicator solution in it that causes it to change color based on the pH of the solution. Referencing the pH chart on their activity sheet, did the water become more alkaline or acidic?

Educator Notes:

ON THIN ICE

TEMPERATURE AND CARBON ABSORPTION

7. Inform students that next, they will test how the temperature of the water affects how quickly the carbon dioxide dissolves.

8. Ask students to confirm that the beakers are labeled #1, #2, and #3 and that each beaker contains three different temperatures of Bromothymol Blue solution.

9. Using the thermometer, have students measure and record on their activity sheets, the temperature of the Bromothymol Blue solution in the three beakers.

10. Once all the groups have recorded the temperatures of the solutions in the beakers, ask them to drop one antacid tablet into each of the beakers and start the timer on their stopwatch.

11. Let students know that once a beaker's color has changed to yellow, they should record the elapsed time from their stopwatch on their data sheet.

PART I: OCEAN ACIDIFICATION AND MARINE LIFE

Part I (Optional – if you do not feel comfortable handling hydrochloric acid safely or do not have access to it or safety equipment, please move on to Part II)

12. Give each group petri dish with a single shell in it. Let them know that now, we will observe what happens to marine life when ocean water becomes acidic. We will use hydrochloric acid, which has a pH of 0, so all students should be wearing gloves and googles.

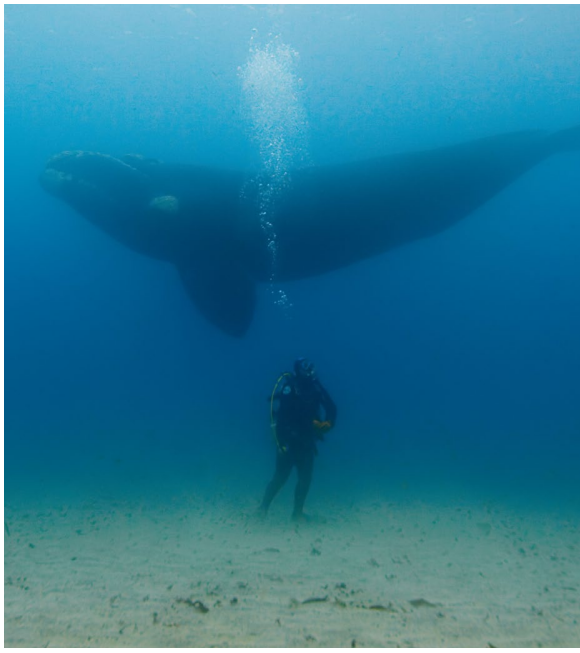
13. Moving from group to group, using a pipette, add HCl onto the shell one drop at a time. Students do not need to touch the shell.

14. Ask the class to discuss and record their observations on their activity sheets.

PART II: OCEAN ACIDIFICATION AND MARINE LIFE

15. Provide each student with two 4 oz. cups, two small pieces of classroom chalk, two pipettes, two pH strips, and a paper towel. Inform students that the classroom chalk will represent the shell of an invertebrate, since it's made of the same materials.

16. Inform students that every two students will share a beaker of vinegar and a beaker of blue water. Instruct students to place their chalk, representing the shell of an invertebrate, in their 4 oz. cups. One cup will be our control and will only have water, with a pH of 7, while the other will be vinegar, with a pH of 2.4. Using a permanent marker, label one cup Sample 1, and the other, Sample 2.



A diver with a southern right whale. This population of around 35,000 whales was decimated by whalers and yet, amazingly, these animal remain inquisitive and gentle around humans.

Photo: BBC NHU

ON THIN ICE

17. Have students place one piece of chalk into each cup.

18. Using their pipette, add blue 'ocean' water to the cup labeled, Sample 1, just enough to submerge the chalk. After about a minute, instruct students to use the pH strip to measure the pH of solution in Sample 1 and record their observations.

19. For Sample 2, use the pipette to add vinegar to the cup, again just enough to submerge the chalk. After about a minute, instruct students to use the pH strip to measure the pH of solution in Sample 1 and record their observations.

20. Have students answer the reflection questions, comparing the two samples and explaining the significance of the findings.

CONCLUSION

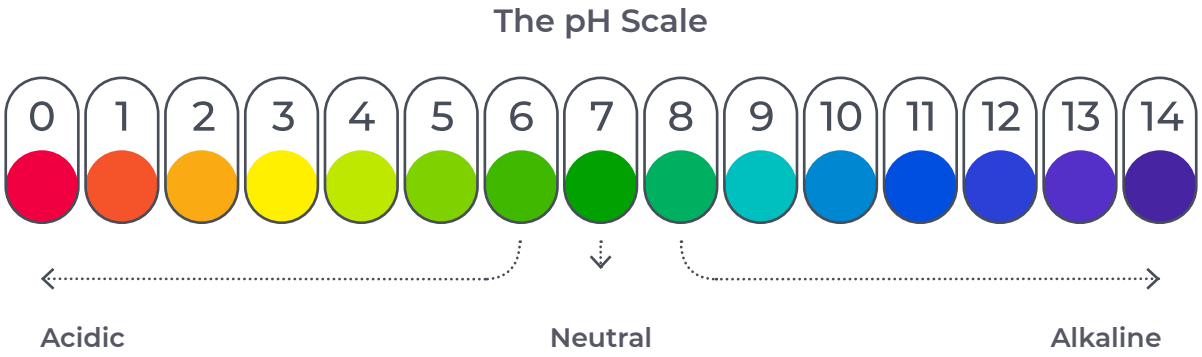
21. Wrap up the lesson by explaining to students that when carbon dioxide dissolves in the ocean some of it mixes with the water molecules to form carbonic acid. This acid can be broken down into two ions, carbonate and bicarbonate. Carbonate is incredibly helpful as it serves as the molecular foundation for marine invertebrates to construct their shells.

Normally, these four elements are balanced, however when there is an excessive amounts of CO_2 the helpful carbonate ions decrease and the not so helpful bicarbonate and carbonic acids increase, lowering the pH of the water. When this more acidic water meets marine life, it can be pretty harmful, as evidence by this experiment. This harm is not limited to animals that build shells. Fish and squid are also affected.

Due to human activities, the ocean is currently becoming more acidic at a rate that is 10x faster than any other time in Earth's history. It is the speed of this change that will make it especially difficult for many marine species to adapt. Scientists are still trying to determine how most marine life will adapt to these rapid changes to ocean chemistry.

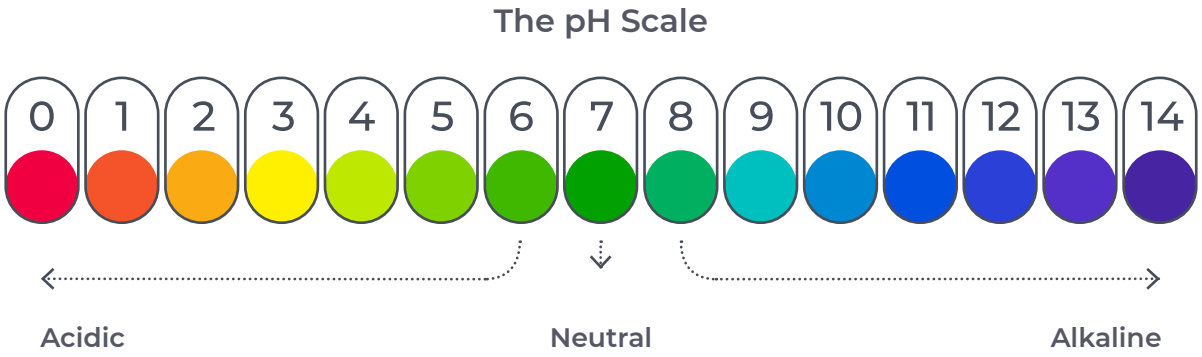
Educator Notes:

CARBON ABSORPTION DEMO



Using the chart above, did the solution become more acidic or more alkaline? How do you know?

CARBON ABSORPTION DEMO



Using the chart above, did the solution become more acidic or more alkaline? How do you know?

The solution became more acidic. I know that because the color of the solution changed from blue to yellow and the pH strip showed that it now has a pH of less than 7, which makes it acidic.

Educator Key

TEMPERATURE AND CARBON ABSORPTION

Procedure

1. Label the beakers on your tray as #1, #2, and #3.

2. Measure the temperature of the three beakers of Bromothymol Blue. Record in the table above.

3. When your educator instructs you, drop one tablet of antacid into each of the three beakers. Have one of your group members start the timer as soon as the antacids enter the water.

4. Observe the solution in the beakers as it changes color. Record in the table the amount of time in minutes it took for the solution to become yellow for each of the three beakers

Use the following table to record the data for how long it takes water to absorb carbon dioxide

	Recorded temperature	Time of Color Change (mins)
Beaker #1		
Beaker #2		
Beaker #3		

TEMPERATURE AND CARBON ABSORPTION

Procedure

1. Label the beakers on your tray as #1, #2, and #3.

2. Measure the temperature of the three beakers of Bromothymol Blue. Record in the table above.

3. When your educator instructs you, drop one tablet of antacid into each of the three beakers. Have one of your group members start the timer as soon as the antacids enter the water.

4. Observe the solution in the beakers as it changes color. Record in the table the amount of time in minutes it took for the solution to become yellow for each of the three beakers.

Use the following table to record the data for how long it takes water to absorb carbon dioxide.

	Recorded temperature	Time of Color Change (mins)
Beaker #1	Data	Data
Beaker #2	Data	Data
Beaker #3	Data	Data

Educator Key

OCEAN ACIDIFICATION AND MARINE LIFE

Part I

Describe what you observed when the hydrochloric acid was added to the shell in the petri dish.

Part II

Add your chalk to the cup. Add in your ocean water slowly, describe what happens as the water interacts with the chalk below. Using pH strips, test the ocean water by using your pipette to pick some up and place drops onto a pH strip. Set this pH strip on a napkin and label underneath it "Sample 1." Compare the color of the strip to the scale provided on its container and write the corresponding value below.

pH of Sample 1: _____

Using a pipette add 1.5 ml of vinegar to the cup, continue to add drops until the chalk begins to dissolve. After each round of adding vinegar, record what happens to the chalk. Once it begins to dissolve, use a pH strip to test the water and record. Set your pH strip on a napkin and label it, "Sample 2." Compare the color of the strip to the scale provided on its container and write the corresponding value below.

pH of Sample 2: _____

OCEAN ACIDIFICATION AND MARINE LIFE

Part I

Describe what you observed when the hydrochloric acid was added to the shell in the petri dish.

When the hydrochloric acid was added to the shell, it began to bubble. It looked like the shell was being slowly broken down by the hydrochloric acid.

Part II

Add your chalk to the cup. Add in your ocean water slowly, describe what happens as the water interacts with the chalk below. Using pH strips, test the ocean water by using your pipette to pick some up and place drops onto a pH strip. Set this pH strip on a napkin and label underneath it "Sample 1." Compare the color of the strip to the scale provided on its container and write the corresponding value below.

pH of Sample 1: 7

The chalk turns darker, and floats in the water before sinking to the bottom. Some bubbles seem to be coming off the chalk, but other than that, it's not doing much of anything.

Using a pipette add 1.5 ml of vinegar to the cup, continue to add drops until the chalk begins to dissolve. After each round of adding vinegar, record what happens to the chalk. Once it begins to dissolve, use a pH strip to test the water and record. Set your pH strip on a napkin and label it, "Sample 2." Compare the color of the strip to the scale provided on its container and write the corresponding value below.

pH of Sample 2: <7

The piece of chalk is fizzing and bubbling as it sits in the vinegar. I can hear it fizzing, almost like an antacid tablet when it's dropped into the water. There are also small pieces of chalk that fall off and are floating in the vinegar.

Educator Key

OCEAN ACIDIFICATION AND MARINE LIFE

How do samples 1 and 2 differ?

Based on this lab, why is it important to monitor the pH of the ocean?

OCEAN ACIDIFICATION AND MARINE LIFE

How do sample 1 and 2 differ?

The chalk in sample one seems to sit in the water and is relatively unaffected by it, while the chalk that sits in the vinegar bubbles a lot and then seems to start to slowly break apart.

Based on this lab, why is it important to keep an eye on the pH of the ocean?

If the ocean water becomes more acidic, it will slowly break down the shells of the animals that live in the water. This would mean that these animals would no longer be able to survive. Not only would many of these animals tragically become extinct, but the ecosystem that relies on them would be harmed as well.

Educator Key

WE'VE GOT LOTS OF ICE, ICE BABY!

GRADE LEVEL 6-8

ANTARCTICA EDUCATOR GUIDE

Photo: © Espen Rekdal

WE'VE GOT LOTS OF ICE, ICE BABY!

GRADE LEVEL 6-8
60 minute Lesson

Standards (NGSS):

MS-LS2-3

Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

From the Film:

In the film ***Antarctica***, students learn about the coldest region on Earth. Throughout the film we see various types of ice showcased including sea ice, glaciers, and icebergs. We also see how this ice is being affected by climate change, and how ice melting affects sea levels throughout the world.

Lesson Overview:

Let students know that they will work in groups to research the different types of ice and make a model of their designated ice type. Groups will present information to the class to the tune of an ice or cold themed song ***(ex: Ice Ice Baby, Let it Go).*** The educator will guide students to a discussion of the differences noted between the different types of ice and demonstrate the effect of Sea Ice Melting vs Ice sheets melting on sea levels.

Materials:

- Technology access for research
- Ice Features handout, p. 93 *(one per student)*
- Ice Demo and Reflection handouts, pp. 95, 97, 99 *(one per student)*
- Two identical clear food storage containers *(about 6" x 6")*
- Clay
- Tray of ice cubes

Water

Ruler

WE'VE GOT LOTS OF ICE, ICE BABY!

EDUCATOR PREP:

Print Ice Features, and Demo with Reflection Handouts
(one per student)

Prepare Ice Melting Demo- Freeze ice cubes at least one day before lesson. Add enough clay to one side of each container, enough to have about 1-2 inches deep of clay.

Press clay down to create a smooth surface, it will represent the land in Antarctica. The clay should take up about a quarter of the container, the rest will be filled with water. Label one container Sea Ice and the other container Ice Sheet.

EDUCATOR GUIDE:

1. In the film, ***Antarctica,*** students were introduced to various types of ice formations. To activate their background knowledge from the movie, ask students to work in pairs to try to answer the following question. Give them about a 60-seconds to see if they can come up with all four:

What are the four types of ice formations mentioned in the film?

The narrator mentions glaciers, ice sheets, sea ice, and icebergs.

2. Bring out the Ice Melting Demonstration. Carefully place enough ice cubes on the clay in the "Ice Sheet" container. Place an equal amount of ice cubes in the "Sea Ice" container on the bottom of the container next the clay. Instruct students they will investigate the effect melting Sea Ice vs melting Ice Sheets has on sea levels.

3. Using their notebook, ask students to make a prediction about which scenario, Sea Ice or Ice Sheets, will have a greater impact on sea levels and why.

4. Add enough water to the sea ice container so that the ice cubes float, and the water level just reaches surface of the clay (it should not go onto the "land"). Do the same for the Ice Sheet container, making sure not to disturb the ice cubes on the clay (again the water should not go onto the "land").

5. Use a ruler to measure the water level in each and note the measurements on the board. Ask students what they think the difference is between ice sheets and sea ice. Inform students you will check on the water levels throughout the class period. Measure and record water levels every 15 minutes.

Antarctic iceberg in the Southern Ocean on a nearly flat sea covered by ice floes.

Some snow petrels are sitting on the top of the iceberg.

Photo: Shutterstock / Armin Rose

WE'VE GOT LOTS OF ICE, ICE BABY!

6. Inform students that while this experiment is going on, they will research the four ice formations mentioned in the film:

Ice Sheet, Sea Ice, Glacier, and Iceberg

Divide students into groups of 3-4. Hand out Ice Features Handout and assign groups to research one of the four ice features and fill out the chart as they proceed.

7. Encourage students to use websites, such as the ones below, to answer the questions for their particular ice formation:

National Science Foundation (NSF)
https://www.nsf.gov/

National Aeronautics Space Administration (NASA)
https://www.nasa.gov/

British Antarctic Survey (BAS)
https://www.bas.ac.uk/

Students they will present the information they find on their ice feature to the class and that you will give them more information on that after the next "sea level" measurement.

8. Circulate to ensure that students and groups are making progress researching the different types of ice.

9. After the next measurement, instruct students that they will share their findings with the rest of the class at the end of the period. Their presentations should be about 2-3 minutes. As a fun twist, tell them they will present it to the tune of an ice or cold themed song, such as ***Ice, Ice, Baby*** or ***Let it Go*** (almost any song from ***Frozen***).

10. Have students fill out their chart on the rest of the ice features during the presentations. Make one final measurement of water levels in the two containers. Ask students to transfer the data that is captured on the board into their notebook.

11. Instruct students to summarize their learning of the similarities and differences between the structures of ice using the reflection questions on their Ice Demo and Reflection activity sheet.

Educator Notes:

WE'VE GOT LOTS OF ICE, ICE BABY!

Ice Features

Directions: Fill out the column of your assigned ice feature as you research facts about it. Use the back of this paper if you need more space.

Guiding Questions	Ice Sheet	Glacier	Iceberg	Sea Ice
What is it?				
Where is it found?				
How is it formed?				
What are its global impacts?				
Interesting Facts?				

WE'VE GOT LOTS OF ICE, ICE BABY!

Ice Features: Educator Key

Directions: Fill out the column of your assigned ice feature as you research facts about it. Use the back of this paper if you need more space.

Guiding Questions	Ice Sheet	Glacier	Iceberg	Sea Ice
What is it?	*A layer of ice that covers land.*	*A mass of ice that covers land and is constantly moving under its own weight*	*A piece of ice that has broken off of an ice shelf or glacier, and is floating in the ocean.*	*Seawater that freezes and floats to the top of the ocean, creating chunks of ice.*
Where is it found?	*Antarctica and Greenland.*	*Mostly in the polar regions, but can also be found at the highest mountain ranges on every continent.*	*Icebergs can be found in the Arctic, Antarctic, and North Atlantic regions.*	*When ocean water freezes, the ice floats to the surface, because it is less dense than the surrounding water.*
How is it formed?	*Water flows over the surface of the earth and then freezes to create the ice sheet covering.*	*Formed as precitipitation collects on the surface. The temperature and air pressure cause it to freeze, thaw, and refreeze.*	*Icebergs break off of glaciers, falling into the ocean. They float into open water until they reach warmer waters and melt.*	*When ocean water freezes, the ice floats to the top, since ice is less dense than water.*
What are its global impacts?	*It holds much of the earth's water. As the earth warms, these ice sheets may melt, causing significant flooding.*	*Contained 90% of the world's freshwater. Due to global warming, glaciers are melting, which could lead to a rise in ocean levels.*	*Since the early 20th century, there have been various attempts to track icebergs, including aerial photos, acoustics, and satellites.*	*There are many types, shapes, and sizes of sea ice. These often melt and refreeze, creating new sea ice as the weather cools.*
Interesting Facts?	*Antarctica's ice sheets cover land that was once very lush and green with dinosaurs living on it.*	*Glaciers are classified by their shape, characteristics, and behavior.*	*When icebergs are melting, they make a whooshing sound. It was a large iceberg that the Titanic collided with, causing it to sink on April 15, 1912.*	*Sea ice can be classifed based on its age, size, whether it's attached to the shoreline, and even the speed by which its moving.*

ICE DEMO AND REFLECTION

Hypothesis:

Which one, sea ice or a sea sheet, melt more (become more liquid) by the end of the period? Why?

Data	Sea Ice (in inches)	Sea Sheet (in inches)
Level of Water at Beginning		
Level of Water after 15 mins.		
Level of Water after 30 mins.		
Level of Water after 45 mins.		

Reflection Questions:

Which container had the most water level rise?

ICE DEMO AND REFLECTION

Hypothesis:

Which one, sea ice or a sea sheet, melt more (become more liquid) by the end of the period? Why?

Student answers will vary but should include an explanation of why they think that their choice will melt more or at a higher rate.

Data	Sea Ice (in inches)	Sea Sheet (in inches)
Level of Water at Beginning	Data from student	Data from student
Level of Water after 15 mins.	Data from student	Data from student
Level of Water after 30 mins.	Data from student	Data from student
Level of Water after 45 mins.	Data from student	Data from student

Reflection Questions:

Which container had the most water level rise?

Student answers should be reflective of the data collected in the table above.

Educator Key

ICE DEMO AND REFLECTION

How do the results compare with your prediction?

Why do you think this happened?

How are glaciers and icebergs related?

ICE DEMO AND REFLECTION

How do the results compare with your prediction?

Student answers will vary but should include an evaluation of their hypotheses as it relates to the data that they collected in the table above.

Why do you think this happened?

Student answers will vary.

How are glaciers and icebergs related?

Glaciers are masses if ice and snow that cover a landmass. Icebergs are pieces of ice floating in the ocean and can be a result of a piece of glacier breaking off and floating off into the water.

Educator Key

ICE DEMO AND REFLECTION

What is the main difference between sea ice and ice sheets?

What did you notice about how sea ice and sea sheet melted?

What are three questions that you could ask to try to understand melting ice caused by climate change affects the planet?

1.

2.

3.

ICE DEMO AND REFLECTION

What is the main difference between sea ice and ice sheets?

Sea ice are chunks of ocean water that freeze and then float to the surface of the sea, while an ice sheet is a layer of ice that covers a landmass.

What did you notice about how sea ice and sea sheet melted?

Student answers will vary, but should include reference to student observations of how the two behaved as well as to the data chart (p. 91) that shows a difference of quantitative data between the two.

What are three questions that you could ask to try to understand melting ice caused by climate change affects the planet?

1. Student answers may vary, but could include: When Antarctic ice melts, how does it affect animals that use it for survival?
2. Student answers may vary, but could include: How much warmer will the climate of Antarctica get and how much of the ice will melt?
3. Student answers may vary, but could include: What is causing the climate of Antarctica to get warmer causing the ice to melt?

Educator Key

WHAT HAPPENS HERE AFFECTS US ALL

GRADE LEVEL 6-8

ANTARCTICA EDUCATOR GUIDE

Photo: © Espen Rekdal

WHAT HAPPENS HERE AFFECTS US ALL

GRADE LEVEL 6-8
60 minute Lesson

Standards (NGSS):

MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

From the Film:

In the film, we learn that things that happen in Antarctica can have a significant impact on the rest of the world. All the ecosystems on Earth are connected, so when one shifts or is thrown out of balance, it will affect the others one way or another.

Lesson Overview:

Through the classic improv game, Machine, students act out biotic and abiotic factors of the Earth's ecosystem. As they simulate the inputs and outputs of the variables, they begin to understand how things in Antarctica may affect other parts of the world. They finish the lesson by answering questions around how temperatures, biodiversity, ocean levels in Antarctica can affect them specifically in the places in which they live.

Materials:

- Ecosystem Role Cards, p. 107
(final count determined by class size)
- Activity Sheets, pp. 108, 110, 112
(one per student)
- Notebook or paper
- Technology to play the "Carbon Sink" video

Watch the video here

WHAT HAPPENS HERE AFFECTS US ALL

EDUCATOR PREP:

If you have never done improv or played the game, Machine, take a look at this video of a class playing a generic Machine game:

https://www.youtube.com/watch?v=LSVGyaZNc10

This activity will require a large open space, so students may need to move desks out of the way or take them outside or to the gym.

1. Tell students that today we are going to look at the ways in which Antarctica is connected to the rest of the planet. The ecosystem of this continent is very much tied to other ecosystems on the other six continents.

2. Inform students that an ecosystem is the way scientists describe all of the relationships between living and nonliving things in a defined community. The living things are described as biotic factors, while the non-living things are called abiotic factors and can include things like geology and weather.

3. Ask students to take a minute and using their science notebook or a piece of paper, try to name as many biotic and abiotic factors in Antarctica, using the film or their general knowledge of the continent. They can write names or sketch pictures, either is fine.

4. Inform students that these biotic and abiotic factors often interact as part of the ecosystem. These interactions are key to how well the ecosystem functions. To illustrated this concept, show students the "Carbon Sink" video and ask them to identify the biotic and abiotic factors involved in this process.

5. Tell students that today we will be playing an improv game called Machine to act out and understand the relationships between biotic and abiotic factors across multiple ecosystems.

6. Explain to students that the class will be divided to role play various ecosystems of Antarctica and from across the world. They will role play one of the following biotic or abiotic factors to explore how these affect the rest of the planet's ecological balance: phytoplankton, carbon, krill, humans, whales, glaciers in Antarctica, and abnormally massive storms and hurricanes. Each group will be influenced by an ***input (something that is acted up them)*** - and will be responsible for an ***output (something they do to, or for, another factor).***

7. Impress upon students that during this activity, they will interact with other students in the class, but that they must do so without actually touching each other. They will instead mime that connection and the transfer of energy from one to another.

A Weddell seal pup and mother.

Weddell seal pups feed on extremely rich milk and double their weight in the first two weeks of their life.

Photo: BBC NHU

WHAT HAPPENS HERE AFFECTS US ALL

8. Divide the class as evenly as possible into seven groups. Each group will play a different role in the following scenarios.

9. For Scenario 1, assign the following roles to the student groups using the cards provided:

Group 1 – Carbon

Group 2 – Phytoplankton

Group 3 – Krill

Group 4 – Whales

Group 5 – Glaciers in Antarctica

Group 6 – Hurricanes and Typhoons

Group 7 – Humans

10. Inform students that you will narrate the scenario and as each group's "character" is called out, they will move to the center of the room to act out their specific role. After the first group begins to act out their role, the next group will connect with them, acting out how they interact in the ecosystem, without touching. Assure them that there is no wrong way to do this and to collaborate with their group members to think about how to best play their role.

11. Narrate Scenario 1 using the following*; pause at points to allow students to step into the Machine:*

"One of the ways in which the Antarctic ecosystem affects the rest of the world is by capturing carbon that is in the atmosphere around the globe".

Group 1 - Carbon is part of carbon dioxide, released by animals including humans through breathing, and by emissions of cars and factories around the globe.
Group 2 - Phytoplankton in the ocean can actually capture carbon and remove it from the atmosphere.
Group 3 - Tiny marine organisms called krill eat the phytoplankton, transferring the carbon from the phytoplankton to the krill.
Group 4 - Using their signature bubble netting technique, whales eat the krill in big gulps.
Group 5 - Glaciers sit idly by and watch patiently.
Group 6 - Since the ecosystem is in balance, hurricanes and typhoons still happen across the ocean, but they are not abnormally strong.
Group 7 - Humans take shelter and weather the storm safely.

Note: after you read the scenario, encourage students to continue playing the ecosystem for another 30 seconds to a minute.

Educator Notes:

WHAT HAPPENS HERE AFFECTS US ALL

12. After completing Scenario 1, facilitate a brief reflection discussion with the group using the following questions:

What are the biotic and abiotic factors of this ecosystem?

Biotic factors are the phytoplankton, krill, whales, and humans. Abiotic factors are the hurricanes, carbon, and glaciers.

How does it feel to play your role in this version of the ecosystem in Antarctica?

No real right or wrong answer here, but it should feel pretty calm, balanced, and not very intense.

13. Ask students to return to the perimeter of the space. Once reset, Inform them that we will now begin Scenario 2, which will modify one variable to behave a little bit differently. ***Ask two students playing phytoplankton, and another playing krill to switch and become extra carbon.***

"It's sometimes a bit hard to wrap our brains around this, but in the last hundred years, humans have invented factories, cars, trains, airplanes, they have pumped more and more carbon into the atmosphere".

Groups 1, 2 - As this carbon is now floating throughout the atmosphere, not all of it can be captured by the phytoplankton, and some stay floating in the air.
Groups 1, 2, 3, 4 - Phytoplankton are still eaten by krill and krill are eaten by whales. However, the extra carbon continues to float in the atmosphere and causes the Ozone layer over the South Pole to be thinned. This is called Ozone Depletion.
Group 5 - Ozone Depletion causes the temperature to increase, which melts the glaciers of the South Seas.
Groups 6, 7 - As a result of the melting glaciers, ocean water rises and warms, causing abnormally massive storms and strong hurricanes and typhoons which destroy structures and can kill humans."

Note – again, after you read the scenario and students have jumped into the action, encourage them to keep the ecosystem going for another few minutes.

A four ton elephant bull seal defending his harem of females. This beachmaster uses his trunk like nose to boom out an almighty roar, warding off intruders.

Photo:
Fredi Devas © BBC NHU

WHAT HAPPENS HERE AFFECTS US ALL

14. After a few minutes of role-playing scenario 2, have students stop and discuss what happened in that scenario and how it's different than scenario 1, using the following questions:

How does the simple act of driving a car have such a wide-ranging effect on a planet that feels so huge to us?

It's not one car that has this impact, but the billions of cars we drive and have driven every single day for the last hundred years. Even though one car, driven by one person, one day wouldn't have this affect, the aggregate is extremely impactful.

In this scenario, we shifted a couple of people's roles to be extra carbon. Is this an accurate representation of what has happened on our planet? Why or Why not? How do we know?

The extra carbon represents the increased carbon emissions post-Industrial Revolution. Although the model is a bit simplified for our purposes, it does represent the impact that the increased carbon has on the atmosphere and the subsequent domino effect.

15. Ask students to use their notebook or journal to reflect on these two scenarios by answering the following questions:

What are the connections between the ecosystems of the six other continents and Antarctica that result in this domino effect from one to the other?

Ocean current, atmospheric currents all contribute to events in Antarctica leading to effects in other parts of the world. Similarly, when carbon is released at a high rate across the globe, that ultimately has an impact on Antarctica.

How can these connections potentially play a role in a solution to slowing down or stopping human-caused climate change?

By understanding how systems interconnect, we can better understand that events don't happen in a vacuum, but instead trigger domino effects across the globe.

16. After finishing the scenarios, have students return to their workstations and complete the reflection sheet. When they finish, review the answers and discuss the implications of the ways in which Antarctica affects the rest of the world.

Educator Notes:

ECOSYSTEM ROLE CARDS

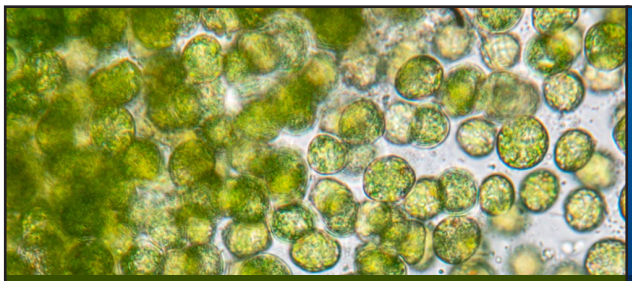


Photo: Shutterstock / Rattiya Thongdumhyu

Phytoplankton

Photo: Shutterstock / Craig Lambert

Whales

Photo: BBC NHU

Glaciers in Antarctica

Photo: Shutterstock / I. Noyan Yilmaz

Krill

Photo: Shutterstock / Harvepino

Hurricanes and Typhoons

Photo: Shutterstock / Aleksandr Ozerov

Humans

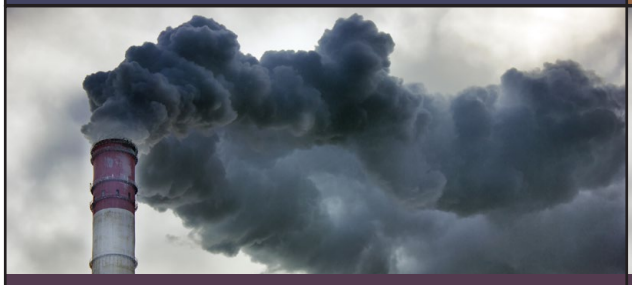


Photo: Shutterstock / Anastasiia Tymoshenko

Carbon

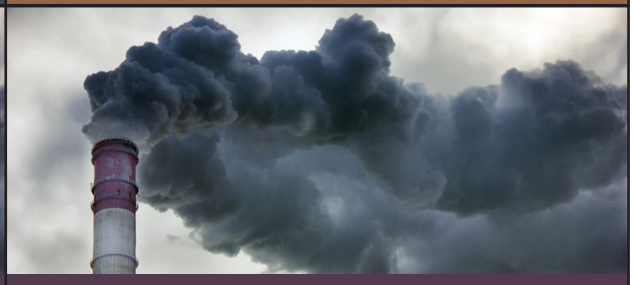


Photo: Shutterstock / Anastasiia Tymoshenko

Carbon

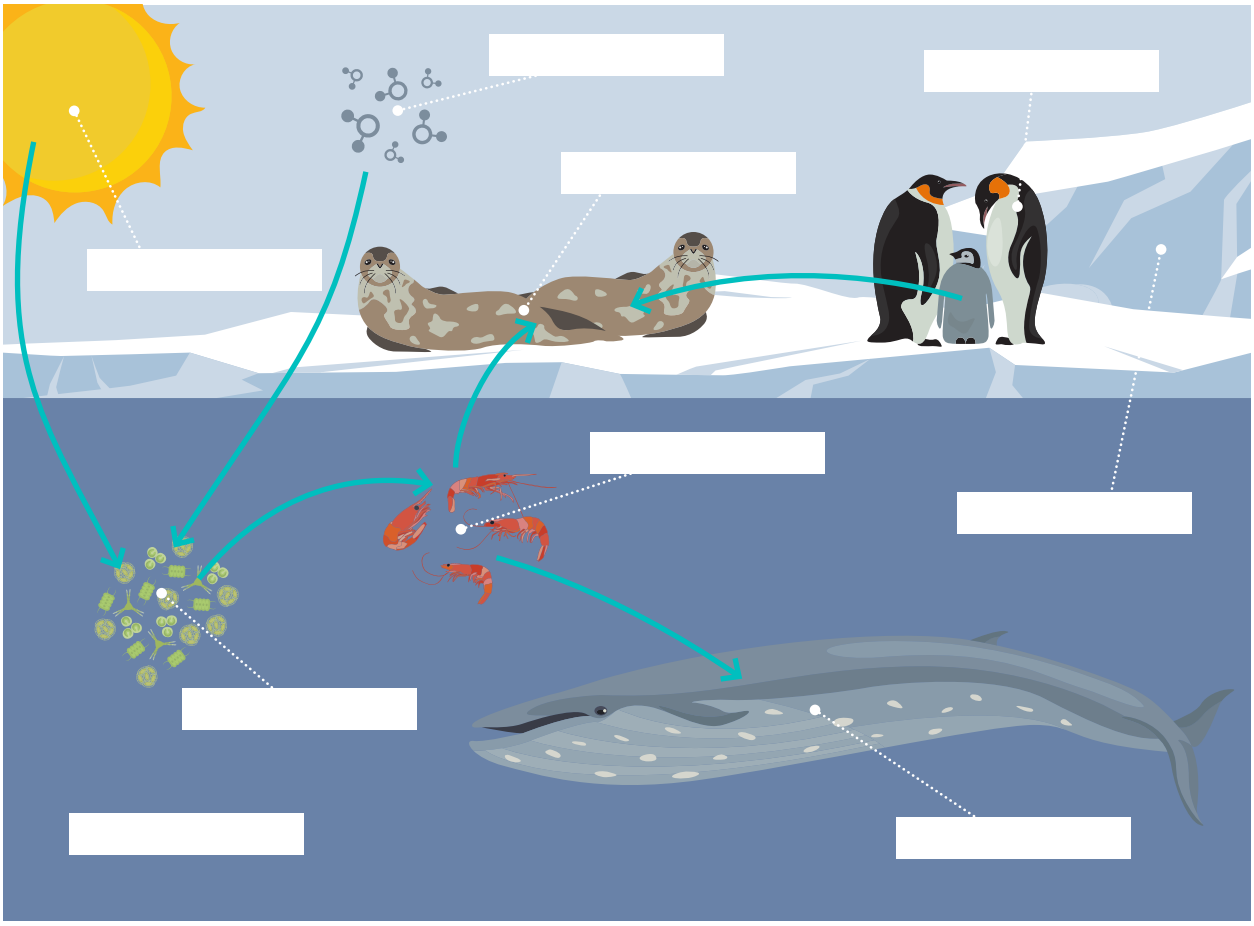
Note: Remember to produce additional carbon cards for Scenario 2.

ACTIVITY SHEET

Complete the following reflection after playing out the two scenarios for how events and conditions in Antarctica can affect places around the world:

Complete this diagram with the biotic and abiotic factors of Antarctica's ecosystem, using the terms below.

Krill	*Whale*	*Carbon*	*Ice*	*Sun*
Penguin	*Ocean*	*Phytoplankton*	*Seals*	



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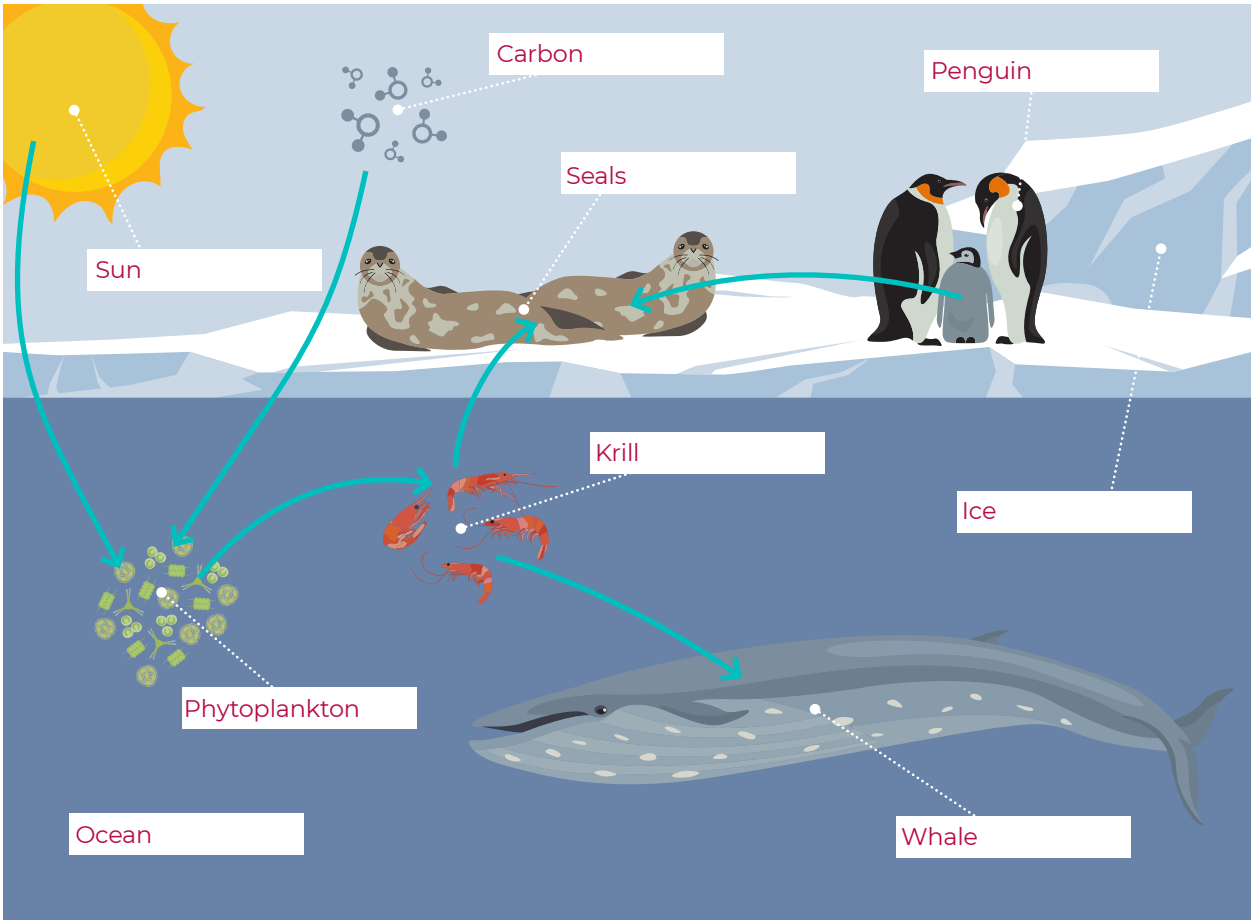
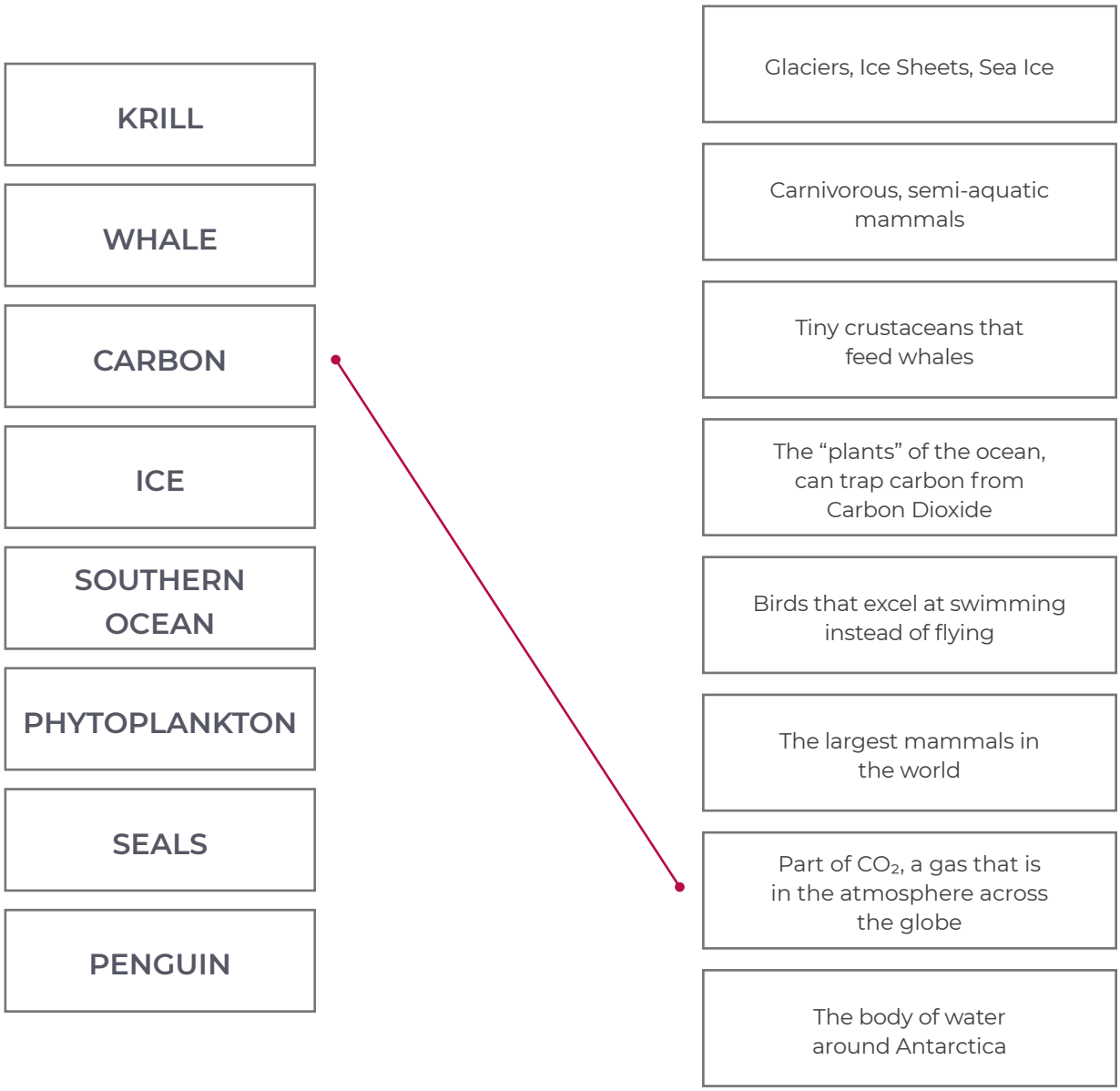


Educator Key

ACTIVITY SHEET

Match the terms with their definitions.



ACTIVITY SHEET

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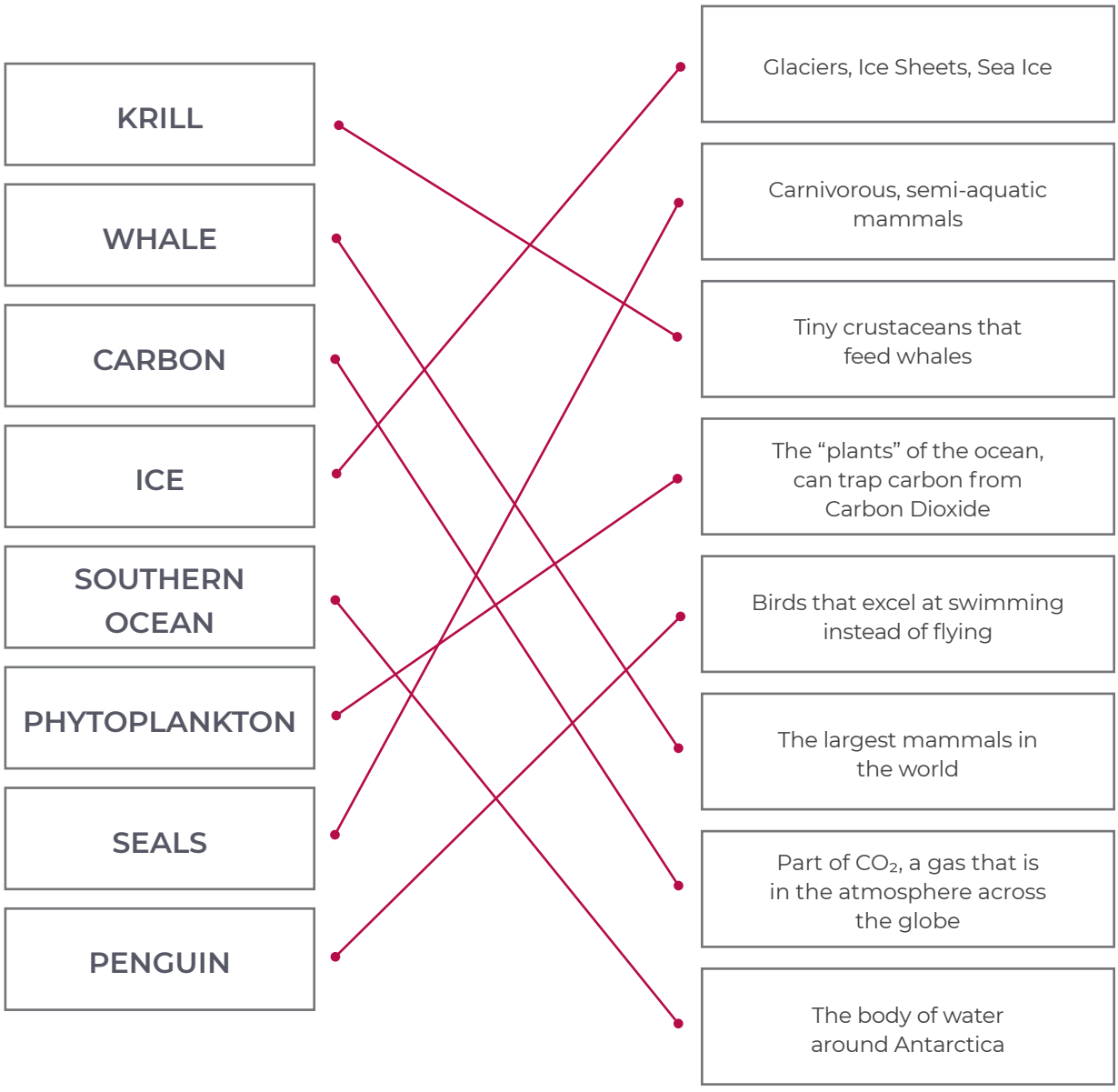

Educator Key

ACTIVITY SHEET

In the scenarios that you and your classmates played out, what was the result of having additional carbon in the atmosphere that were more than what the phytoplankton were able to capture?

How did the unbalanced ecosystem on Earth affect life in Antarctica?

How did the unbalanced ecosystem on Earth affect life in other places in the world?

How does what happens in Antarctica affect life in other parts of the planet?

ACTIVITY SHEET

In the scenarios that you and your classmates played out, what was the result of having additional carbon in the atmosphere that were more than what the phytoplankton were able to capture?

When there were additional carbon in the atmosphere, it caused the atmosphere to warm up, which melts glaciers, increasing ocean levels, and creating more powerful storms. This causes an unbalanced ecosystem which threatens the wellbeing of all plants and animals, including human beings.

How did the unbalanced ecosystem on Earth affect life in Antarctica?

The unbalanced ecosystem meant that there were not enough phytoplankton to feed the krill, which meant that whales did not have anything to eat. The whale population diminished and the ecosystem as a whole struggled to stay intact.

How did the unbalanced ecosystem on Earth affect life in other places in the world?

The unbalanced ecosystem created a more powerful hurricane, causing destruction and death. Additionally, the warming of the air in Antarctica lead to warming of the ocean and the air in other parts of the world which threatened those ecosystemns as well. Finally, the unbalanced ecosystem, melted the glaciers and increased ocean levels, which threatened sealife and humans who rely on the ocean for stable weather, food, and habitat.

How does what happens in Antarctica affect life in other parts of the planet?

The ocean currents and wind patterns carry what happens in Antarctica to other places in the world. When it gets warm in Antarctica, there is a domino effect that occurs across the planet, resulting in changing temperatures, higher sea levels, more intense weather patterns, and an unbalanced ecosystem.

Educator Key