

## DATA IN THE CLASSROOM: LEVEL 1

# How Does Rising CO<sub>2</sub> Impact Ocean pH?

1. Calculating Change Over Time: How much have CO<sub>2</sub> levels in the ocean changed over time? Use the graph to answer the question.

How much has CO<sub>2</sub> in the ocean increased since 1988?

*To calculate percent change, find the difference between the starting and ending values, and then divide by the starting value.*

2. Make a Prediction: Observe the graph showing CO<sub>2</sub> measurements at Mauna Loa Observatory, Hawaii, from 1958 to 2018. Then, predict the likely effect of rising CO<sub>2</sub> on ocean pH by completing the table below.

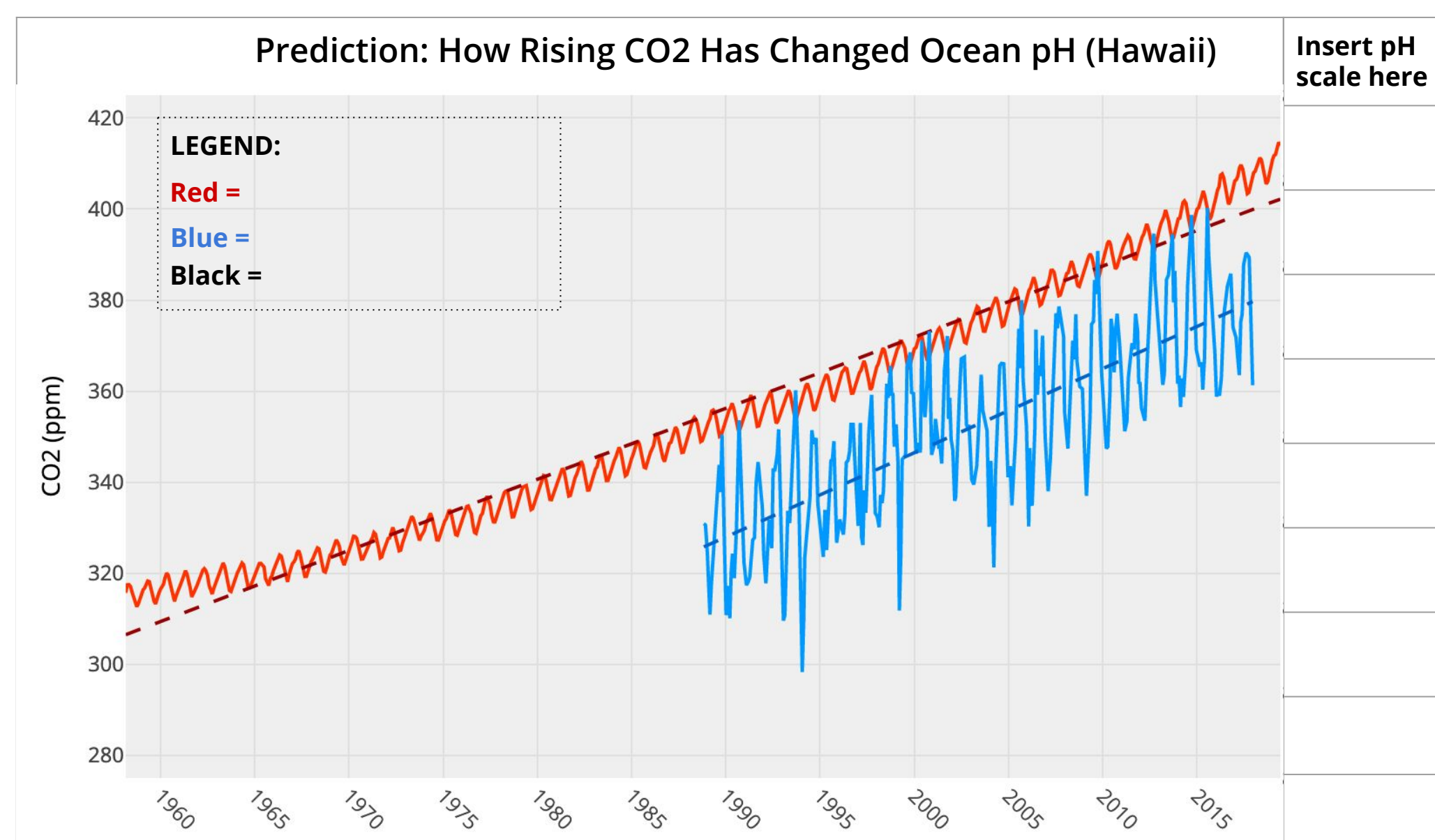
In 1988, the pH of the ocean was approximately 8.1. What do you predict the pH of the ocean is today?

Explain why you made your prediction above. Use evidence from the graph (hint: explain how changes in atmospheric CO<sub>2</sub> and ocean CO<sub>2</sub> could have caused pH to change).

What are the primary chemical reactions that may explain your predictions?

*Use chemical equation(s) or words or both.*

3. Illustrate Your Prediction: Illustrate your prediction by drawing a black line on the graph below. See instructions.
- Complete the legend (black will represent ocean pH)
  - Create a pH scale along the y-axis on the right side of the graph. *Note: Do NOT make your scale from 0 to 14. Keep it centered around your prediction.*
  - Find the year 1988 on the x-axis. Ocean pH was 8.1 in 1988. Place a black dot at this location on the graph.
  - Starting from the dot, create a line that shows your predicted change in ocean pH from 1988 to current.



Type your y-axis values directly into each of the rows in the table.

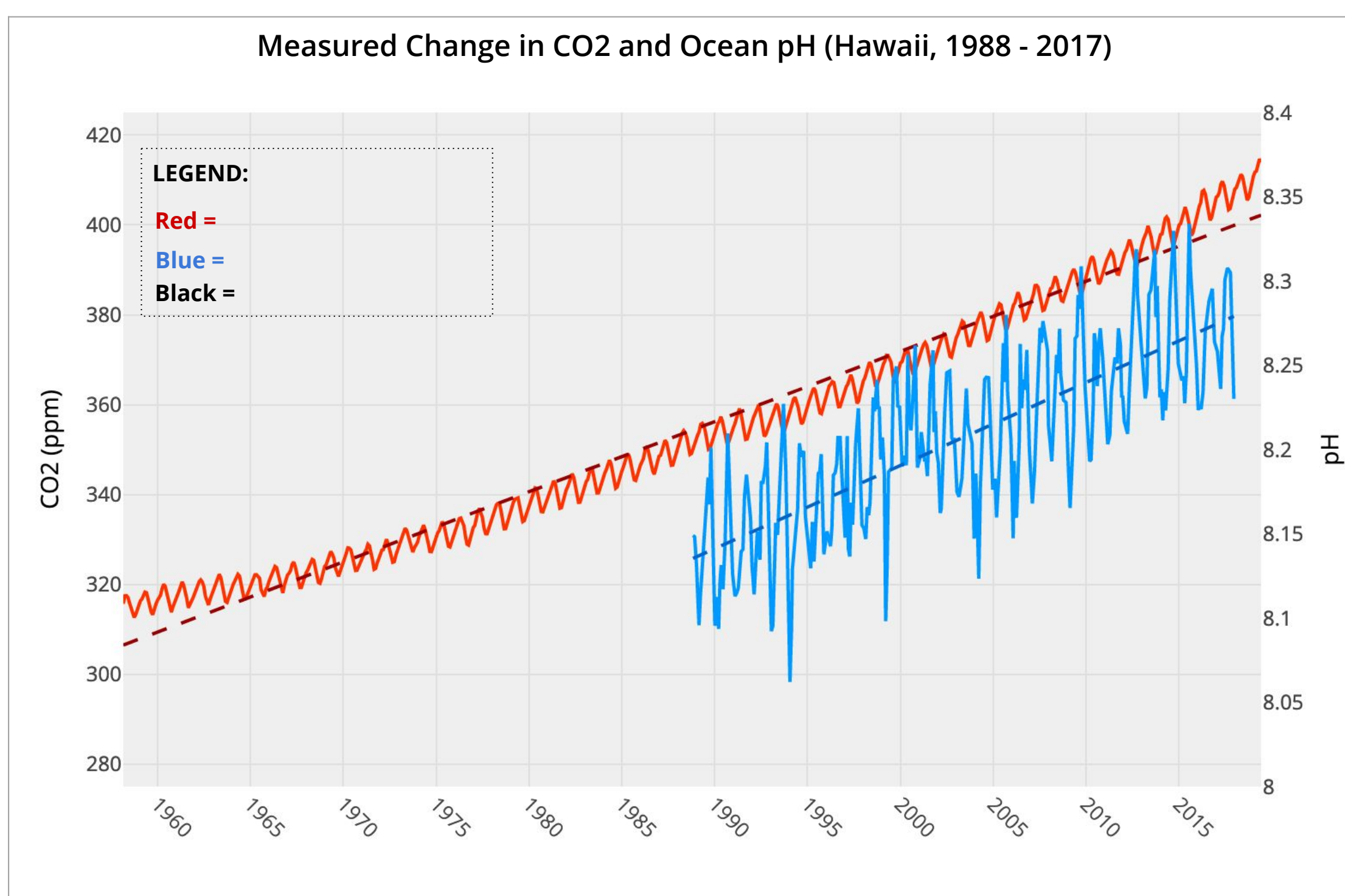
## DATA IN THE CLASSROOM: LEVEL 2

# Measuring Changes in pH

1. Predicted vs Actual Change in Ocean pH: After completing the online activities in Level 2, compare your predictions from Level 1 with the actual changes in ocean pH.

What words or numbers complete the sentences?	Type the 2 missing words or values below.
My prediction was that pH would ..... [increase or decrease] by ..... pH units.	
The data show that pH actually ..... [increased or decreased] by ..... pH units.	

2. Illustrate the Actual Change in Ocean pH: Draw a line on the graph to show the actual change in ocean pH over time.
- Note: the pH scale along the secondary y-axis is completed for you.
  - Complete the legend (black will represent ocean pH)
  - Draw a black trend line on the map to show the long-term trend in ocean pH over time.



3. Analyzing Short & Long-term Changes in Ocean pH: How much does ocean pH vary over short and long time scales?

CO <sub>2</sub> and pH both change in a predictable pattern from year to year. Describe the pattern.	
What causes the predictable pattern?	
What is ocean acidification? <i>Define the term in your own words.</i>	

## DATA IN THE CLASSROOM: LEVEL 3

# Examining Acidification Along the Coast

1. How is acidification different along the coast? Watch the interactive animation & answer the question below.

In addition to the absorption of CO <sub>2</sub> from the atmosphere, identify and describe TWO processes that can affect ocean pH closer to shore?	
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2. Detecting Acidification Near the Coast: Use the map tool to collect & analyze ocean pH data at two locations, Hawaii and coastal Washington, between 2010 and 2017. Record below.

Location	Highest pH value	Lowest pH value	Range (highest - lowest pH)
Cha Ba (Washington)			
WHOTS (Hawaii)			

3. Construct an Explanation: Is ocean acidification is occurring in Washington, in the same way that it is in Hawaii? Answer the question using the claim, evidence, reasoning table below.

Is ocean acidification is occurring in Washington, in the same way that it is in Hawaii?	My Claim:
Include specific data measurements from the graphs & from the table in #2 above.	My Evidence:
Connect the evidence to your claim	My Reasoning:

4. Coastal Acidification: How would you define coastal acidification? Use your answers in Q1-3 to help form a definition, in your own words.

<i>My definition for Coastal Acidification</i>	
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## DATA IN THE CLASSROOM: LEVEL 4

# Acidification's Impact on Animals

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4. Construct an Explanation: Given the current conditions in Washington, will larval oysters have enough aragonite to grow and build shells? Answer the question using the claim, evidence, reasoning table below.

Given the current conditions in Washington, will larval oysters have enough aragonite to grow and build shells?	My Claim:
Include specific data measurements from the data table in #3.  Describe any patterns that you notice, including seasonal patterns.	My Evidence:
Connect the evidence to your claim.  Need some help with this section? Consider the following questions.  <i>In natural systems, oysters reproduce in the summer months. Will larval oysters be able to build their shells given the current summertime conditions?</i>  <i>Could larval oysters experience lethal conditions at any point during the year?</i>	My Reasoning:

## DATA IN THE CLASSROOM: LEVEL 5

# Design an Investigation

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**1. Develop Your Question:** Ask a question that can be answered using the data available in Level 5 of the module.

Some sample questions are below.

- How has water chemistry in the Gulf of Maine been affected by global increases in atmospheric CO<sub>2</sub>?
- Does ocean pH in the Gulf of Maine follow the same seasonal pattern as coastal Washington?
- Do the current conditions in the Gulf of Maine support the growth and survival of the soft-shell clam?
- In 20, 50 or 100 years, will conditions in the Gulf of Maine be suitable for soft-shelled clams and other shellfish?

Identify a question of interest about acidification.	
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**2. Collect Data:** Identify the data that you need to answer your question. If possible, paste or attach your data maps or charts to this document.

Data	Date	Map or Graph
<i>Example: Gulf of Maine, Ocean pH</i>	<i>2010 - 2015</i>	<i>graph</i>

**3. Use the claim, evidence, reasoning format to help answer your question.**

Claim: Record a simple statement that answers your question and is based upon evidence.	
Evidence: Include specific data from the the data maps, graphs or charts you have analyzed.	
Reasoning: Connect the evidence to your claim.	