Performance Task: Ocean Acidification

PART 1: Research
Student Directions

Your Assignment:

A serious issue facing our environment is ocean acidification. You have been asked to research this issue as it affects a local industry: oyster farming. You will gather data from a variety of sources, answer three research questions, and write an explanatory essay about ocean acidification and its effects on local oyster industries. This essay is designed to educate the public about ocean acidification and its impact on the oyster industry.

Steps you will follow:

To plan and write your essay, you will do all the following:

1. Watch three videos.
2. Read an article.
3. Interpret data charts.
4. Answer three questions about the readings and the videos.
5. Plan and write your essay.

Directions for beginning:

You will read the article, view the infographic, interpret data charts, and watch three videos, while taking notes with the template provided. You may refer to the media sources and your notes when writing your essay.

Source List:

Video #1:	Ocean Acidification: NOAA (3:57) https://youtu.be/jST0q2KaYcA
Video #2:	*Acid Water Takes its Toll on Puget Sound Shellfish* (6:28) https://youtu.be/ZzrYvkxpHTw
Video #3:	*Oyster Farmers Facing Climate Change* (4:36) https://youtu.be/FiaXulwAbQI
Article:	*Are Oysters Doomed?* Dolan, M. (2013, February 18). Source link: http://slate.me/2DjBK4s
Data Charts:	#1: pH Scale #2: Rate of Ocean Acidification #3: Mean pH at Sea Surface Projected Over Time

Note-Taking Template

Researching Ocean Acidification and its impact on the oyster industry.

Media Source	What ocean acidification is and how we know it is happening?	Why ocean acidification is a problem to oysters and other shellfish?	Possible Solutions
Video #1: *Ocean Acidification: NOAA*			
Video #2: *Acid Water Takes its Toll on Puget Sound Shellfish*			

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Note-Taking Template

Researching ocean acidification and its impact on the oyster industry.

Media Source	What ocean acidification is and how we know it is happening?	Why ocean acidification is a problem to oysters and other shellfish?	Possible Solutions
Video #3: *Oyster Farmers Facing Climate Change*			
Article: *Are Oysters Doomed?*			

Performance Task: Ocean Acidification

Note-Taking Template

Media Source	What ocean acidification is and how we know it is happening?	Why ocean acidification is a problem to oysters and other shellfish?	Possible Solutions
Data Chart #1: *pH Scale*			
Data Chart #2: *Rate of Ocean Acidification*			
Data Chart #3: *Mean pH at Sea Surface Projected Over Time*			

Article

Are Oysters Doomed?

Don't believe in climate change? Talk to a clam digger.

By Maria Dolan | Posted Monday, Feb. 18, 2013, at 1:20 PM

A worker shucks a fresh oyster at the Drakes Bay Oyster Co. in June 2007 in Point Reyes Station, Calif.
Photo by Justin Sullivan/Getty Images

Behind the counter at Seattle's Taylor Shellfish Market, a brawny guy with a goatee pries open kumamoto, virginica, and shigoku oysters as easily as others pop soda cans. David Leck is a national oyster shucking champion who opened and plated a dozen of them in just over a minute (time is added for broken shells or mangled meat) at the 2012 Boston International Oyster Shucking Competition. You have to be quick, these days, to keep up with demand. The oysters here were grown nearby in Taylor's hundred-year-old beds, but the current hunger for pedigreed mollusks on the half shell stretches to raw bars and markets across the country.

A similar oyster craze swept the United States in the 1800s, when the bivalves were eaten with alacrity in New York, San Francisco, and anywhere else that could get them fresh. Development of a fancy new technology, canning, meant there was money in preserved oysters, too. Gold miners in Northern California celebrated their riches with an

oyster omelet called 'hangtown fry'. New Yorkers ate them on the street; late at night they ate them in "oyster cellars." Walt Whitman had them for breakfast.

That wave crashed. By the early 1900s, oysters were disappearing because of overharvesting and water pollution. Today's revival is possible because oyster farms are better managed, and regulations have improved water quality. But a modern threat looms for ice-chilled *fruits de mer* platters, although it's hard to tell with oyster juice on your chin. This time it's a worldwide problem, affecting marine ecosystems everywhere.

Ocean waters are turning corrosive, and it's happening so quickly scientists say there may not be any oysters left to eat in coming decades.

Ocean acidification, as scientists call this pickling of the seas, is, like climate change, a result of the enormous amount of carbon dioxide humans have pumped into the atmosphere. Oceans have absorbed about a quarter of that output, and ocean chemistry has changed as a result. Surface water pH has long been an alkaline 8.2, not far from the pH of baking soda, but it now averages about 8.1.

That doesn't look like much, but since pH is a logarithmic scale, that means a 30 percent increase in the acidity. By the end of this century, surface water pH could further lower to 7.8 or below.

We don't yet know who the ocean's winners and losers will be in the more corrosive world. Jellyfish and some seagrasses may thrive under more acidic conditions. On the other hand, calcifiers—organisms that make calcium carbonate shells and skeletons, such as shellfish and corals—appear to be in trouble. In the United States, scientists have seen dissolving clam larvae in Maine, corroded oysters in Washington state's hatcheries, and mussels with thinned shells off the Pacific Northwest coast.

Taylor Shellfish first saw what this pH shift could do to its business in 2006, when the company noticed that two- and three-day-old oyster larvae in its hatcheries were dying. In itself, this wasn't news. "Hatcheries have a lot of different variables," says Bill Dewey, Taylor's spokesperson. "There are a host of reasons your larvae can die." But this time, none of the usual fixes—filtering out harmful bacteria, for instance—made a difference. By 2009, hatchery production was down 60 to 80 percent, and others in the region were reporting similar problems.

Oyster larvae outside of hatcheries were dying, too. In Willapa Bay, an estuary off the southwest Washington coast where a quarter of the nation's oysters are harvested, many growers rely on natural sets—free-spawning larvae that swim around until they attach themselves to oyster shells placed by growers. Those natural sets stopped producing, and the Willapa growers turned to the struggling hatcheries for oyster seed.

The industry finally pulled out of its tailspin in 2010, when NOAA scientists determined that what was killing the oyster larvae was corrosive water that entered the hatchery at certain times of the year—usually in summer, and specifically on days when winds from the northwest caused upwelling of deeper

water, which is more acidic than surface water.
With federal money, hatcheries were able to install sophisticated pH monitors and CO2 monitors. When waters are becoming too corrosive, hatchery operators can now close off the seawater intake, and, Dewey says, "pray that the winds change soon."

Unlike other problems caused by CO2, ocean acidification is spurring some action, possibly because the effects are so visibly tied to the cause. "With climate change there's often a schism between scientists and those who flat out don't want to believe it," says Green. "It's hard to get a man to believe something if his job depends on not believing it." But in this case, he says, it's the people in the industry who are leading awareness. "Talk to shellfish clammers—the guys who dig—and every one of them is on board, especially the old timers. They have seen over the years the populations go from incredibly productive to virtually disappearing in many cases." One bit of anecdotal evidence diggers have reported is clams with thinner shells—so thin, they say, that sometimes it's not possible to fill bushel baskets to the top because the fragile shells at the bottom will be crushed.

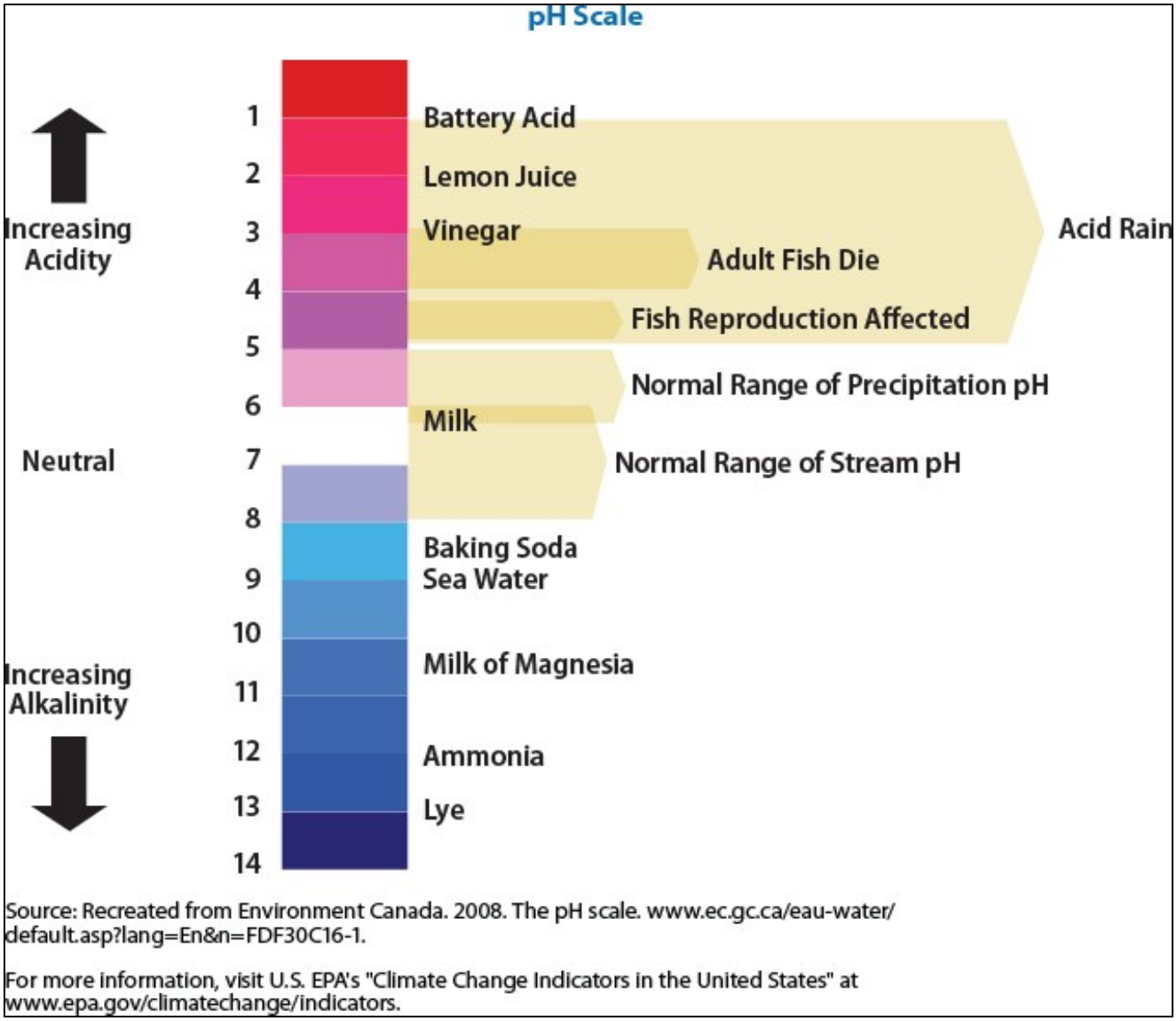
For the diggers, a scientific fix is the only hope they have of saving their industry. But even the best near-shore solution can't stop the pH drop that's taking place oceanwide, not unless we plan to stop releasing carbon dioxide into the atmosphere and replace it with Milk of Magnesia.

The long-term projections for ocean acidification make people even more anxious. **"**Even if we change our CO2 emissions policies today, the problem's going to get worse in the next 30 to 50 years before it gets better," says Dewey, given how long carbon dioxide persists in the atmosphere. "We're anticipating that down the road it is probably going to affect our adult oysters as well as our seedlings."

By midcentury, it's likely that about 50 percent of the seawater will be too corrosive for growing oysters. "Seawater conditions are getting such that they are dissolving our animals, and the source of that problem is global CO2 emissions—what can we possibly do? Even a big shellfish company like ours can't fix that problem." States Dewey.

As with climate change, ocean acidification will require more comprehensive, aggressive measures. But, hey, if we don't fix this? We'll need to invent some new recipes for jellyfish and seagrass.

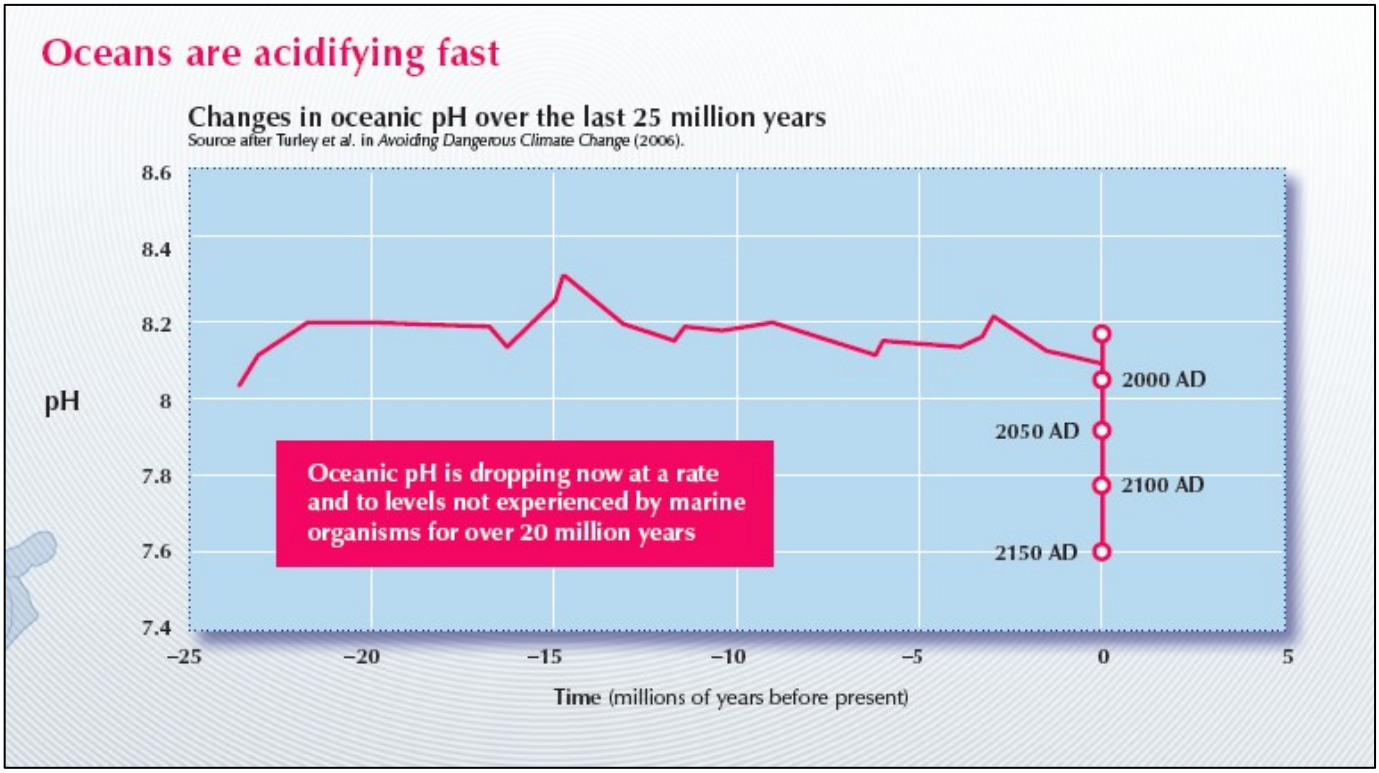
Data Chart #1: pH Scale



Source: Recreated from Environment Canada. 2008. The pH scale. www.ec.gc.ca/eau-water/default.asp?lang=En&n=FDF30C16-1.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/indicators.

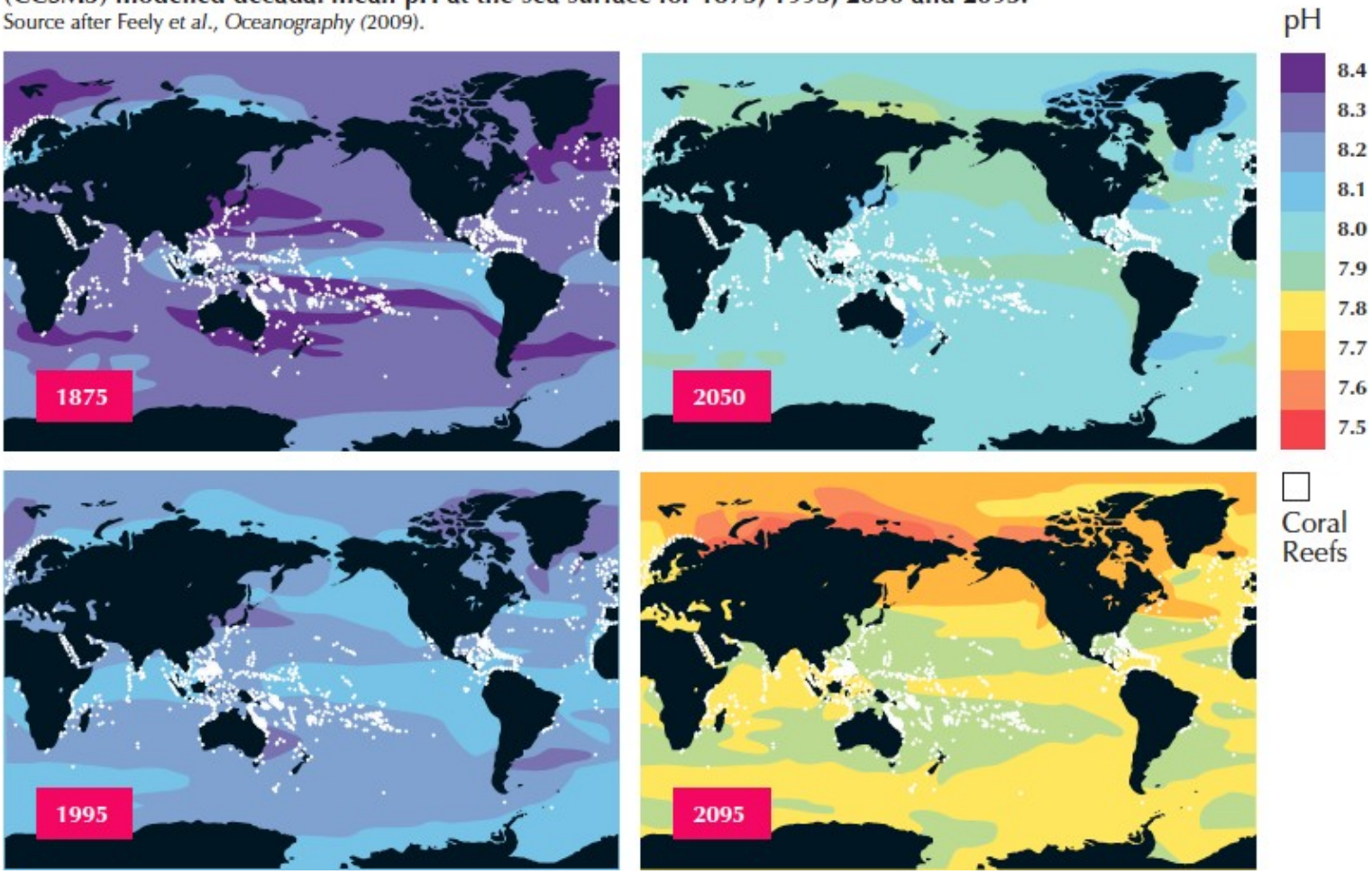
Data Chart #2: Rate of Ocean Acidification



***Source:* *Ocean Acidification Questions Answered* *and the* *UK Programme*.**

Data Chart #3: Mean pH at Sea Surface Projected Over Time

National Center for Atmospheric Research Community Climate System Model 3.1 (CCSM3) modelled decadal mean pH at the sea surface for 1875, 1995, 2050 and 2095.
Source after Feely *et al.*, *Oceanography* (2009).



***Source:* *Ocean Acidification Questions Answered* and the *UK Programme*.**

Performance Task: Ocean Acidification

1. **How would you define ocean acidification, and what evidence would you provide to show that it is a problem? Use information from the article, the data charts and at least one of the videos to support your answer. Cite your sources.** ***(Claim 4, Target 2)***

2. **Compare and contrast the presentation and content of the three videos. Which video is most useful in showing the impact of ocean acidification on our local oyster industry? Cite evidence from the three videos in your response. Cite your sources.** ***(Claim 4, Target 3)***

3. **Based on your research, how would you respond to the following question: *Are Oysters Doomed?* Cite your sources. *(Claim 4, Target 4)***

Part 2: Field Investigation

Arrange for students to participate in water testing and monitoring. Adopt a local water way to monitor over time and post your data to share with others. Provide opportunities for community education and outreach regarding the issue of ocean acidification. Visit an industry affected by ocean acidification like the shellfish industry and find out what measures are being taken to address the impact of ocean acidification.

Discussion questions might include the following:

- What is ocean acidification and why should we care?
- How do scientists monitor for ocean acidification?
- What is happening worldwide regarding ocean acidification?
- How might ocean acidification affect Washington State's economy?
- What actions might individuals take to address the issue of ocean acidification?

In addition, teachers may want to consider one or more of the following field investigations:

- NOAA/PMEL Carbon Program – What is OA: https://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidific ation%3F

- Smithsonian Ocean Portal: http://ocean.si.edu/ocean-acidification

Other ideas for field investigations:

Performance Task: Ocean Acidification

Part 3: Essay

You will now have time to review your notes and sources, plan, draft, and revise your essay. You may use your notes and refer to the sources. Read your assignment and the information about how your essay will be scored. Then begin your work.

Your Assignment:

You have been asked to research the issue of ocean acidification and its impact on our local oyster farming industry. Your job is to explain what ocean acidification is, how this problem is affecting the oyster industry, and suggestions for what we can do to reduce ocean acidification. Your essay will be published in a local journal used to educate the public about this important environmental issue. Use information from both print and video sources in your essay. Cite your sources.

How your essay will be scored:

1. ***Statement of Purpose/Focus*** – how well your response is fully sustained and consistently and purposefully focused.
2. ***Organization*** – how well the ideas progress from the introduction to the conclusion using effective transitions.
3. ***Elaboration of Evidence*** – how well you provide support evidence for your topic and includes effective use of sources.
4. ***Language and Vocabulary*** – how well you effectively express ideas using precise language that is appropriate for your audience and purpose.
5. ***Conventions*** – how well you follow the rules of usage, punctuation, capitalization, and spelling.

Now begin work on your essay.

- Review your notes.
- Plan your essay using the template provided
- Write your essay
- Revise and edit for a final draft

Performance Task: Ocean Acidification

Planning My Essay

Essay Components
Introduction: Capture the reader's attention.
Statement of purpose or controlling idea:
What we mean by ocean acidification:
How ocean acidification is affecting our local shellfish industry:
Ways we can reduce ocean acidification and protect our shellfish industry:
Conclusion:

Scoring Rubric

1. How would you define ocean acidification, and what evidence would you provide to show that it really is a problem? Use information from the article, the data charts and at least one of the videos to support your answer. Cite your sources. *(Claim 4, Target 2)*

Analyze/Integrate Information Rubric (Claim 4, Target 2)	
2	• The response gives sufficient evidence of the ability to gather, analyze, and integrate information within and among multiple sources of information.
1	• The response gives limited evidence of the ability to gather, analyze, and integrate information within and among multiple sources of information.
0	• A response gets no credit if it provides no evidence of the ability to gather, analyze, and integrate information within and among multiple sources of information.

2. Compare and contrast the presentation and content of the three videos. Which video is most useful in showing the impact of ocean acidification on our local oyster industry? Cite evidence from the three videos in your response. Name your sources. *(Claim 4, Target 3)*

Evaluate Information / Source Rubric (Claim 4, Target 3)	
2	• The response gives sufficient evidence of the ability to evaluate the credibility, completeness, relevancy, and/or accuracy of the information and sources.
1	• The response gives limited evidence of the ability to evaluate the credibility, completeness, relevancy, and/or accuracy of the information and sources.
0	• A response gets no credit if it provides no evidence of the ability to evaluate the credibility, completeness, relevancy, and/or accuracy of the information and sources.

3. Based on your research, how would you respond to the following question: *Are Oysters Doomed?* Cite your sources. *(Claim 4, Target 4)*

Use Evidence Rubric (Claim 4, Target 4)	
2	• The response gives sufficient evidence of the ability to cite evidence to support arguments and/or ideas.
1	• The response gives limited evidence of the ability to cite evidence to support arguments and/or ideas.
0	• A response gets no credit if it provides no evidence of the ability to cite evidence to support arguments and/or ideas.

Informative / Explanatory Writing Rubric
(Grades 6- 11) Scoring Version

Score	4	3	2	1
Statement of Purpose/Focus	**The response is fully sustained and consistently and purposefully focused:** • consistent or main idea of a topic is clearly communicated, and the focus is strongly maintained for the purpose, audience, and task	**The response is adequately sustained and generally focused:** • controlling or main idea of the topic is clear, and the focus is mostly maintained for the purpose, audience, and task	**The response is somewhat sustained and may have a minor drift in focus:** • controlling or main idea of a topic may be somewhat unclear, and the focus may be insufficiently sustained for the purpose, audience, and task	**The response may be related to the topic but may provide little or no focus:** • controlling or main idea of the topic may be somewhat confusing or ambiguous; response may be too brief or the focus may drift from the purpose, audience, and task
Organization	**The response has a clear and effective organizational structure creating unity and completeness:** • consistent use of a variety of transitional strategies to clarify the relationships between and among ideas • effective introduction and conclusion • logical progression of ideas from beginning to end; strong connections between and among ideas, with some syntactic variety	**The response has an evident organizational structure and a sense of completeness, though there may be minor flaws and some ideas may be loosely connected:** • adequate use of transitional strategies with some variety to clarify the relationships between and among ideas • adequate introduction and conclusion • adequate progression of ideas from beginning to end; adequate connections between and among ideas	**The response has an inconsistent organizational structure, and flaws are evident:** • inconsistent use of transitional strategies with little variety • introduction and conclusion, if present, may be weak • uneven progression of ideas from beginning to end; and/or formulaic; inconsistent or unclear connections between and among ideas	**The response has little or no discernible organizational structure:** • few or no transitional strategies are evident • introduction and conclusion, if present, may be missing • frequent extraneous ideas may be evident; ideas may be randomly ordered or have an unclear progression
Elaboration of Evidence	**The response provides thorough and convincing support/evidence for the controlling idea and supporting idea(s) that includes the effective use of sources, facts, and details.** • comprehensive evidence from sources is integrated; references are relevant and specific • effective use of a variety of elaborative techniques*	**The response provides adequate support/evidence for the controlling idea and supporting idea(s) that includes the use of sources, facts, and details:** • adequate evidence from sources is integrated; some references may be general • adequate use of some elaborative techniques*	**The response provides uneven, cursory support/evidence for the controlling idea and supporting idea(s) that includes uneven or limited use of sources, facts, and details:** • some evidence from sources is weakly integrated, imprecise, or repetitive; references may be vague • weak or uneven use of elaborative techniques*; development may consist primarily of source summary	**The response provides minimal support/evidence for the controlling idea and supporting idea(s) that includes little or no use of sources, facts, and details:** • evidence from the source material is minimal or irrelevant; references may be absent or incorrectly used • minimal, if any, use of elaborative techniques*
Language	**The response clearly and effectively elaborates ideas, using precise language:** • vocabulary is clearly appropriate for the audience and purpose • effective, appropriate style enhances content	**The response adequately elaborates ideas, employing a mix of precise with more general language**: • vocabulary is generally appropriate for the audience and purpose • generally appropriate style is evident	**The response elaborates ideas unevenly, using simplistic language:** • vocabulary is uneven or somewhat ineffective for the audience and purpose • inconsistent or weak attempt to create appropriate style	**The response is vague, lacks clarity, or is confusing:** • vocabulary is limited or ineffective for the audience and purpose • little or no evidence of appropriate style

Score	2	1	0
Conventions	**The response demonstrates a command of conventions:** • adequate use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling	**The response demonstrates partial command of conventions:** • limited use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling	**The response demonstrates little or no command of conventions:** • infrequent use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling

NS	**Unintelligible, in a language other than English, off-topic, insufficient evidence (incomplete) or copied text. (Off-purpose writing will still receive a score in Conventions.)**

**Elaborative techniques may include the use of personal experiences that support the controlling idea.*