



Ocean Acidification Effects on Organisms &
Solving an Environmental Challenge

Minute Paper

- What is ocean acidification?
Explain as best you can.
- Which organisms do you think might be affected by ocean acidification, and how?



Ocean Acidification

- Since the start of the Industrial Revolution, the ocean has gotten 25% more acidic.
- Caused by excess CO₂ entering the atmosphere and then being absorbed by the ocean
- Extra CO₂ comes from the burning of fossil fuels
- Atmospheric CO₂ levels have been steadily increasing since the Industrial Revolution.

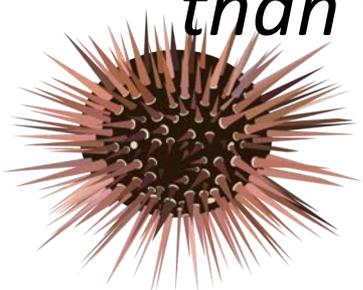


Exploration Question



What happens to some ocean organisms if the ocean absorbs more CO₂ than they are adapted for?

- *Which organisms' parts might break down in water with a lower pH than they are adapted for?*
- *Can shells form if ocean water has a lower pH than they are adapted for?"*



“Break Down” Investigation

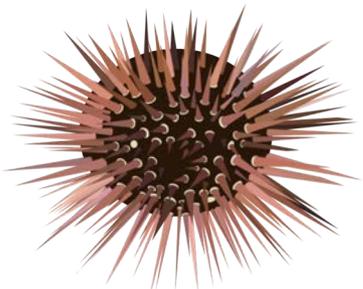
1. Spoon a small amount of each of the appropriate materials in each of the labeled spots on the petri dish (seaweed, jellies, shells/corals).
2. Predict what will happen when “lower pH water” is dropped on each of these materials.
3. Using the eyedropper, add a few drops of “lower pH water” to each material on your plate.
4. Note what happens to each material.
5. Discuss these questions:
 - *Which materials seem to be most affected by lower pH water?*
 - *Are any of the materials unaffected by the lower pH water? If so, which ones?*



Discussing Results



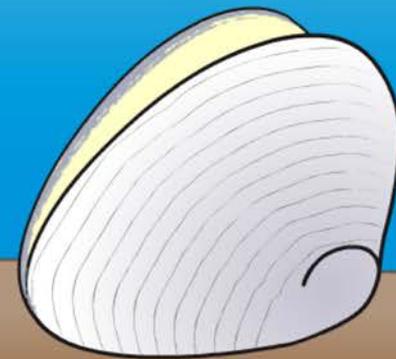
- *What types of organisms might be affected by ocean acidification based on your evidence so far?*
- *Which organisms might fare well in a more acidic (lower pH) ocean?*



Carbon dioxide, shell building, and ocean acidification

Seawater is a soup of dissolved substances, chemicals, and ions. To build shells and skeletons, marine organisms, such as this hypothetical clam, extract calcium ions (Ca^{2+}) and carbonate ions (CO_3^{2-}) from seawater, combining them into solid crystals of calcium carbonate (CaCO_3) that are laid down to make shells.

START



Turn and Talk

- Based on what you know about shell formation, how do you think falling ocean pH may impact organisms' abilities to make shells?

“Build Up” Investigation

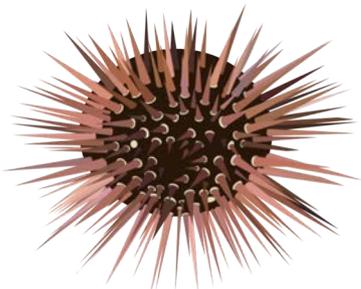
1. Note three cups on the sheet of paper labeled, 1, 2 and 3 and a line reading higher pH at one end and lower pH at the other end. Each cup contains limewater. Line the cups up from 1 to 3, with #1 closest to the higher pH end of the line, cup #2 in the middle of the line, and cup #3 at the lower pH end of the line.
2. Drop 10 drops of vinegar into cup #2.
3. Drop 20 drops of vinegar into cup #3.
4. Using litmus paper, measure the pH in each cup to confirm placement on the pH line.
5. Cover each of the cups with a lid.
6. When CO_2 mixes with Calcium in water, sometimes calcium carbonate is formed. ***Predict what will happen*** when you add CO_2 to each cup by breathing into them through a straw. This will mimic CO_2 naturally being absorbed by ocean water. You will be able to tell if calcium carbonate forms in the cups because the cup will become cloudy from the white calcium carbonate.
7. Unwrap the straws; insert one straw through the lids into each of the three cups of limewater. Do not drink the water. Give each of the cups to different people.
8. At the same time, have each person holding a cup use their straw to blow air into the solution in the cup. Air bubbles should be apparent in the solution. Have each person blow for the same amount of time—about 30-45 seconds.
9. Record observations of each of the cups and answer the wrap-up question: *Which of the cups of water seems to have more calcium carbonate available for organisms to use to build shells? What is your evidence?*



Discussing Results



- Which water was the cloudiest? Least cloudy?
- Which of the waters appears to have more calcium carbonate available for building shells? How do you know?
- How is shell building connected to atmospheric CO₂ concentrations?

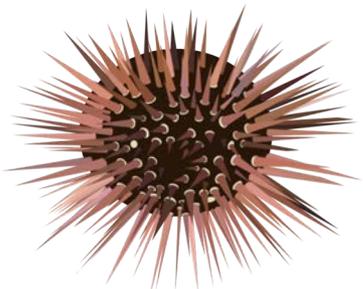


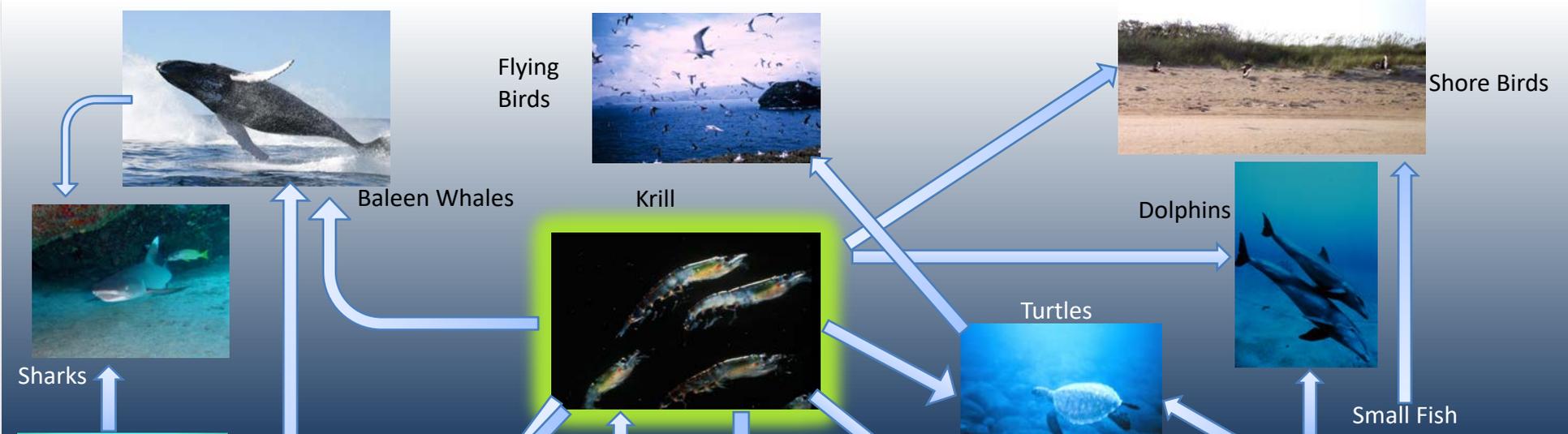


Models in science



- In what ways were the ocean acidification models we just used accurate?
- In what ways were they inaccurate?





Based on the available evidence, what can you say about direct and indirect effects of ocean acidification on organisms?



Minute Paper Revisited

- What is ocean acidification?
Explain as best you can.
- Which organisms do you think might be affected by ocean acidification, and how?



Key concepts

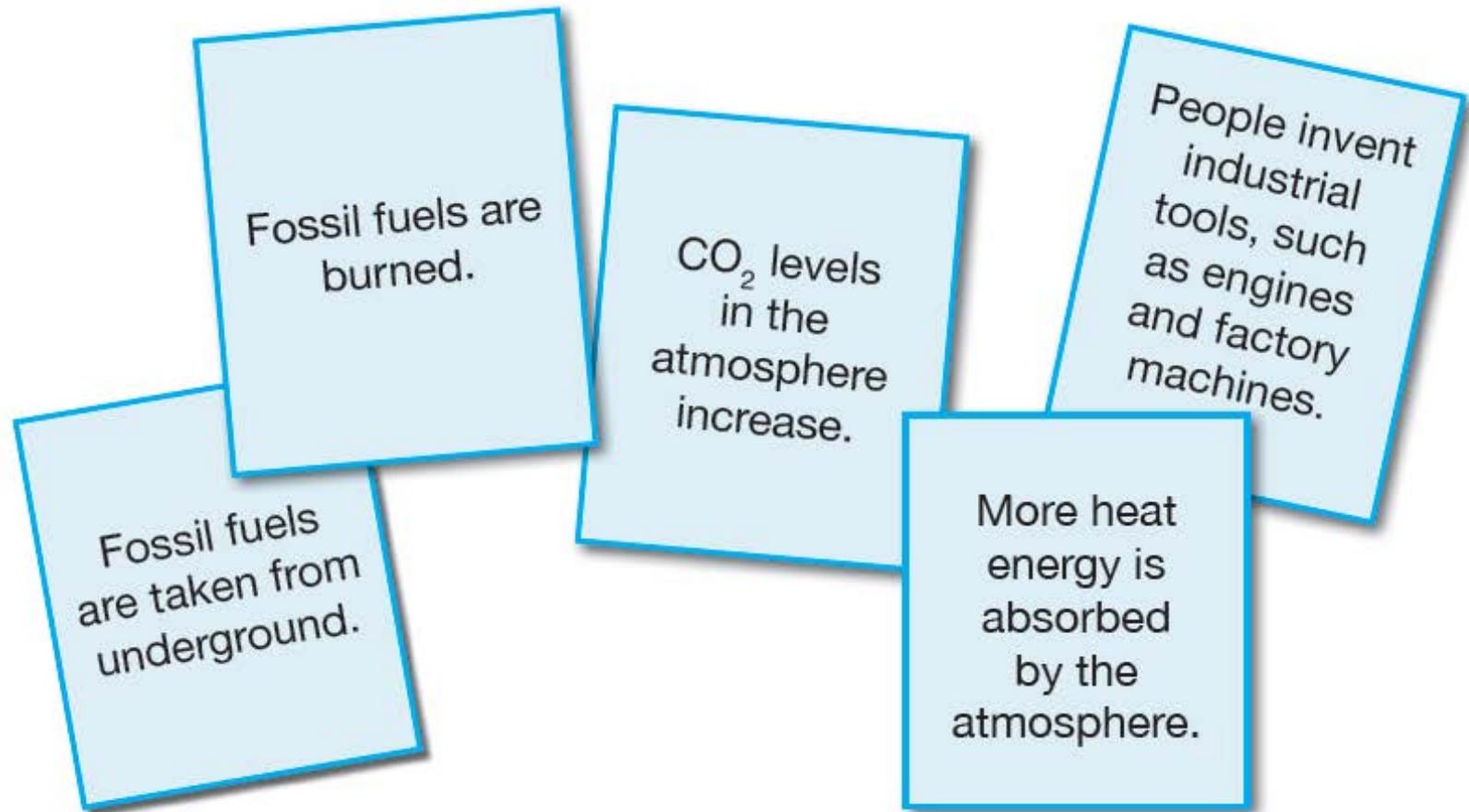
- Ocean acidification is caused by

- The effects of ocean acidification include

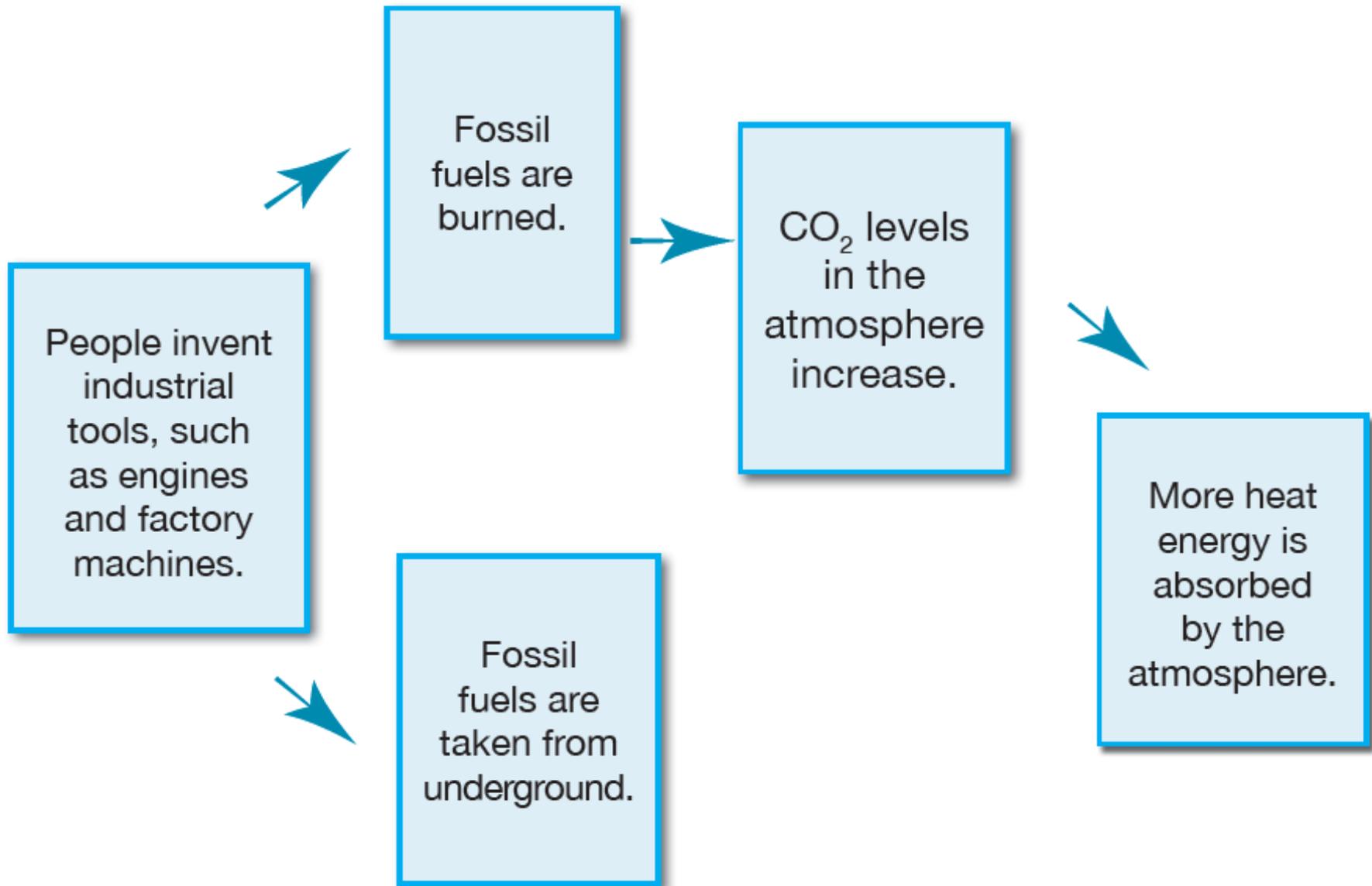
Section E. Ocean Acidification: Cause and Effect Flow Chart

Make a Flow Chart

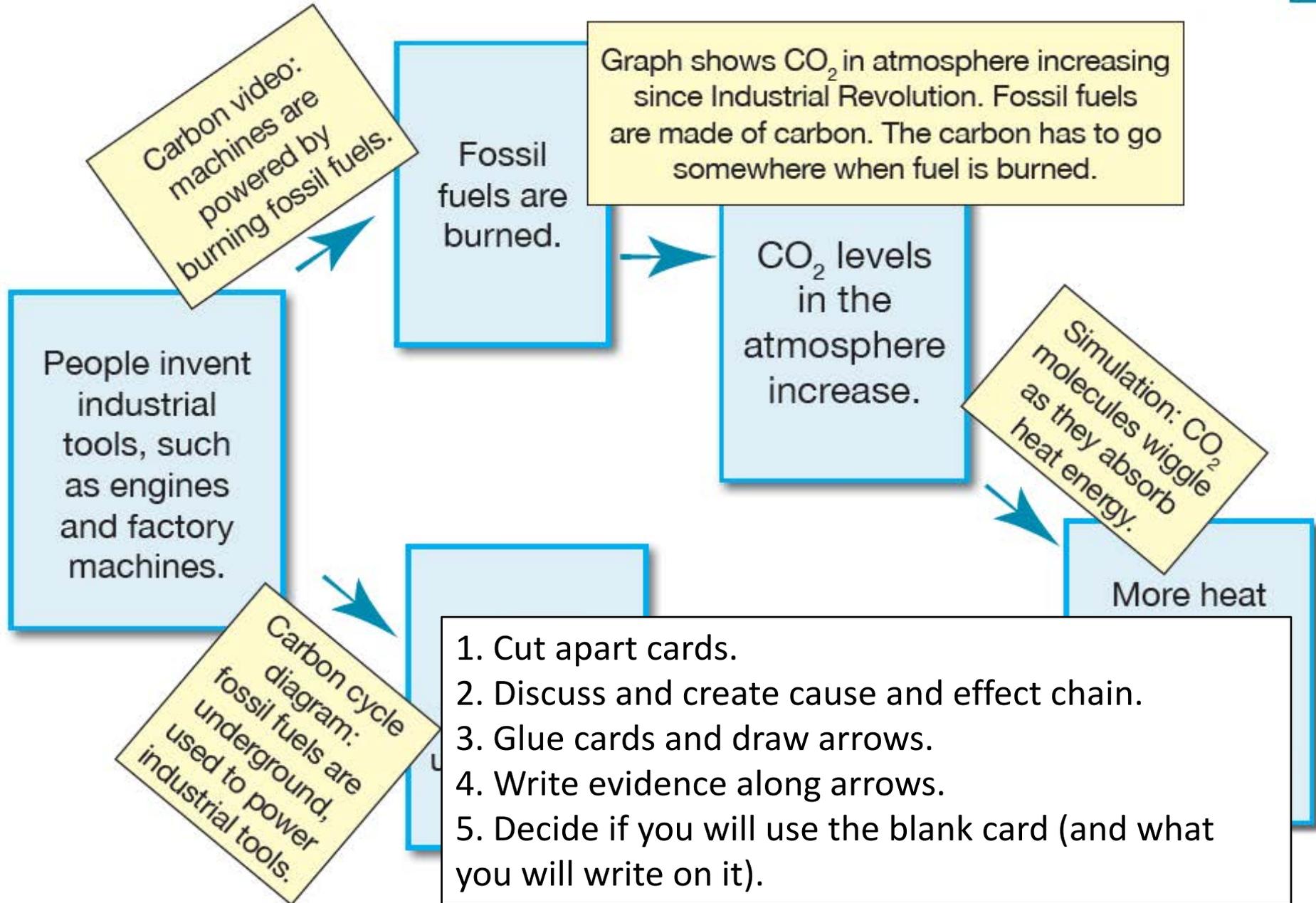
How could you make a cause and effect flow chart with these cards?



Flow Chart Example



Flow Chart with Evidence



Section F. Solving Local
Environmental Challenges:
Ocean Acidification

Background: Effects of Ocean Acidification and Oysters

- Read:
 - Background section of handout
 - First page of “Like Putting Headlights on a Car”
- Create a written list of the challenges faced by the shellfish industry



Ocean Acidification's Impact on Oysters and Other Shellfish



Designing a solution to the problem facing oyster growers...

Imagine you are an oyster grower in the Pacific Northwest, with many families, employees, restaurants and seafood distributors that depend on you for oysters and livelihood. In order to maintain production of healthy oyster larvae, you need to pump fresh ocean water into your hatchery daily until they reach a size when they are less vulnerable to changing environmental conditions (approximately 2 weeks). However, if you pump ocean water into your hatchery that is too low in pH, millions of oyster larvae might die and shellfish growers will be left without oyster seed.”

Making it locally relevant...

- What are some of the local, ocean-based industries in your area? If you don't have any local ones, what are some ocean-based industries overall?
- Which of these might be impacted by ocean acidification?
- If not ocean acidification, are there other changes in the oceans related to pH, water quality or climate that would have an impact on these industries?

Comparing Solutions

1. What are some of the solutions that oyster growers implemented to deal with low pH waters in the Pacific Northwest? Were these similar to the solutions your group proposed?
2. What ocean observing technologies were used to assist in the solution described in the NOAA article?
3. This exercise has focused on oysters in the Pacific Northwest. Based on your own ideas and the PBS video, what other coastal industries are potentially affected by ocean acidification?

Exit Ticket

- What questions do you still have about the effect of ocean acidification on organisms?
- What is the most confusing or muddiest point for you?