**Darkening Sea**

By Elizabeth Kolbert

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**Directions:** Answer the following questions in **COMPLETE** sentences

Since the start of the industrial revolution, humans have burned enough coal, oil, and natural gas to produce some two hundred and fifty billion metric tons of carbon. The result, as is well known, has been a transformation of the earth’s atmosphere. The concentration of CO2 in the air today—three hundred and eighty parts per million—is higher than it has been at any point in the past six hundred and fifty thousand years, and probably much longer. At the current rate of emissions growth, CO2 concentration will top five hundred parts per million—roughly double pre-industrial levels—by the middle of this century. It is expected that such an increase will produce an eventual global temperature rise of between three and a half and seven degrees Fahrenheit, and that this, in turn, will prompt a string of disasters, including fiercer hurricanes, more deadly droughts, the disappearance of most remaining glaciers, the melting of the Arctic ice cap, and the inundation of many of the world’s major coastal cities. But this is only half the story.

Ocean covers seventy per cent of the earth’s surface, and everywhere that water and air come into contact there is an exchange. Gases from the atmosphere get absorbed by the ocean and gases dissolved in the water are released into the atmosphere. When the two are in equilibrium, roughly the same quantities are being dissolved as are getting released. But change the composition of the atmosphere, as we have done, and the exchange becomes lopsided: more CO2 from the air enters the water than comes back out. In the nineteen-nineties, researchers from seven countries conducted nearly a hundred cruises, and collected more than seventy thousand seawater samples from different depths and locations. The analysis of these samples, which was completed in 2004, showed that nearly half of all the carbon dioxide that humans have emitted since the start of the nineteenth century has been absorbed by the sea.

1) What scientific evidence is there to prove that ocean acidification is occurring?

When CO2 dissolves, it produces carbonic acid, which has the chemical formula H2CO3. As acids go, H2CO3 is relatively innocuous—we drink it all the time in Coke and other carbonated beverages— but in sufficient quantities it can change the water’s pH. Already, humans have pumped enough carbon into the oceans—some hundred and twenty billion tons—to produce a .1 decline in surface pH. Since pH, like the Richter scale, is a logarithmic measure, a .1 drop represents a rise in acidity of about thirty percent. The process is generally referred to as “ocean acidification,” though it might more accurately be described as a decline in ocean alkalinity. This year alone, the seas will absorb an additional two billion tons of carbon, and next year it is expected that they will absorb another two billion tons. Every day, every American, in effect, adds forty pounds of carbon dioxide to the oceans.

Because of the slow pace of deep ocean circulation and the long life of carbon dioxide in the atmosphere, it is impossible to reverse the acidification that has already taken place. Nor is it possible to prevent still more from occurring. Even if there were some way to halt the emission of CO2 tomorrow, the oceans would continue to take up carbon until they reached a new equilibrium with the air. As Britain’s Royal Society noted in a recent report, it will take “tens of thousands of years for ocean chemistry to return to a condition similar to that occurring at pre-industrial times.

Humans have, in this way, set in motion change on a geologic scale. The question that remains is how marine life will respond. Though oceanographers are just beginning to address the question, their discoveries, at this early stage, are disturbing. A few years ago, Fabry finally pulled her cloudy shells out of storage to examine them with a scanning electron microscope. She found that their surfaces were riddled with pits. In some cases, the pits had grown into gashes, and the upper layer had started to pull away, exposing the layer underneath.

2) Why is it impossible for humans to reverse ocean acidification?

LiveScience Video Notes:  
1) How much has ocean acidity increased by since the industrial revolution?

2) How does ocean acidification affect sea creature’s shells?

3) How will ocean acidification affect coral reefs?

Ocean Acidification and the Arctic

1. How much carbon dioxide has been absorbed by the ocean?

2) Why is ocean acidification worse at the polar regions?