Student Sheet 1

CRITICAL THINKING ACTIVITY: THE STORY IS IN THE ICE!

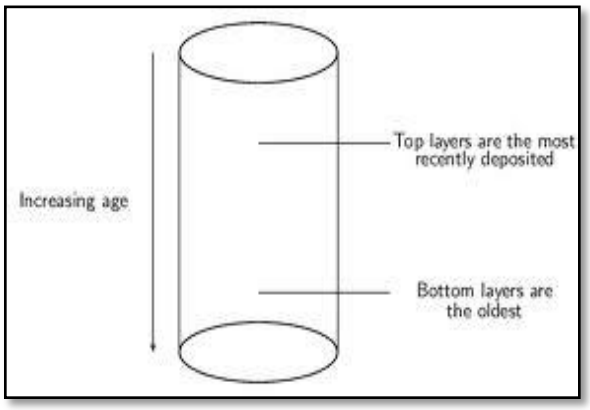
Global warming is a very controversial issue. Some people are convinced that the increase in average global temperature is directly related to the increase in atmospheric concentrations of carbon dioxide. Others argue that the changes in the climate that we are seeing are part of a natural pattern. In order to understand what is really happening at present, scientists need to understand the conditions in Earth's past atmosphere and the factors that affected its temperature.

Once way to study past atmospheric conditions is with ***ice core drilling***. Snow that is compressed into ice forms distinct layers. These layers can be read like the pages of a book- if you know the language. Ice contains dust from volcanic eruptions and desert windstorms, pollen, microbes, meteorites, and small, trapped bubbles of "fossil air." The ice and the impurities it holds provide information about the Earth's environment and climate at the time the ice formed. All of this data provides scientists with a very detailed look at past seasons and can be used to reconstruct a detailed record of climate over hundreds of thousands of years.

Ice cores can be several miles long, but are cut into 1-meter lengths so they can be handled easily. To get at the data contained in the ice cores, they must be melted so that the water from the outside of the core does not mix with the water from the center of the core. The water from the center of the core is analyzed to see changes in climate conditions.

Student Sheet 2

Drilling an ice core from the surface down is like taking a journey back in time. The deeper into the ice you go, the older the layer of ice is. By analyzing the gases and the oxygen isotopes that are present in the ice layers, scientists are able to piece together a picture of what the Earth's climate must have been like in the past.



One of the most well-known ice cores was drilled at the Russian research station, Vostok, in central Antarctica. The Vostok research station is located near the center of the Antarctic ice sheet (78°S 106°E). Ice core samples taken at the Vostok station are used to collect data on historical carbon consist dioxide levels. The data consists of measurements of the percentage of atmospheric gasses, such as CO_2 in fossil air bubbles that have been trapped in snowflakes and compressed into ice over 400,000 years old. Data is kept at NOAA's World Data Center for Paleoclimatology and spans 3,623 meters and over 400,000 years. The Vostok Station represents a partnership between Russian, US, and French scientists. Ice cores taken from the Vostok station contain a record of atmospheric gas composition. Measurements of 'fossil' air trapped in bubbles in ice cores allow scientists to recreate the historical rise and fall in greenhouse gasses, such as CO_2. Measurements made on ice cores taken from the Vostok station provide a pre-historical record of CO_2 variations, providing a natural starting point that can be compared to current CO_2 levels (400.4 ppm) that are influenced by human activity. Studies of ice cores also provide a history of glacial cycles and ancient changes in atmospheric gas composition, with CO_2 levels ranging from 180 ppm during periods of lower temperatures to 280 ppm during warmer periods.

Student Sheet 3

DATA TABLE: CO_2 CONCENTRATIONS VS.TEMPERATURE VOSTOK STATION, ANTARCTICA

Years before present (x 1000)	Local Temperature °C	Carbon dioxide ppm
160	-9	190
150	-10	205
140	-10	240
130	-3	280
120	+1	278
110	-4	240
100	-8	225
90	-5	230
80	-6	220
70	-8	250
60	-9	190
50	-7	220
40	-8	180
30	-7	225
20	-9	200
10	-2	260
0 (1850)	-0.5	280
PRESENT	+3.5	400.4

Student Sheet 4

ANALYSIS:

1. Compare the graphs that you have drawn. What do you notice?
2. Is there a relationship between temperature and the atmospheric concentration of carbon dioxide?
3. Do these graphs prove that temperature changes are determined by the concentration of gases like carbon dioxide in the atmosphere? Explain your answer.
4. What other factors might need to be considered when analyzing climate trends?
5. Does there appear to be any correlation between the major high and low points on the graphs? Explain using specific examples.
6. What does the data suggest about the relationship between temperature and the amount of atmospheric carbon (CO_2)?
7. Which of the two variables, temperature or CO_2, appears to have begun rising first?
8. Examine the relationship between temperature and CO2 for the period from 20,000 years ago to the present.
9. Based on your observations of the data, hypothesize about the relationship between temperature and the amount of CO_2 in the atmosphere.
10. What is the percentage of growth of atmospheric CO_2 since the start of the Industrial Revolution? Hypothesize why.