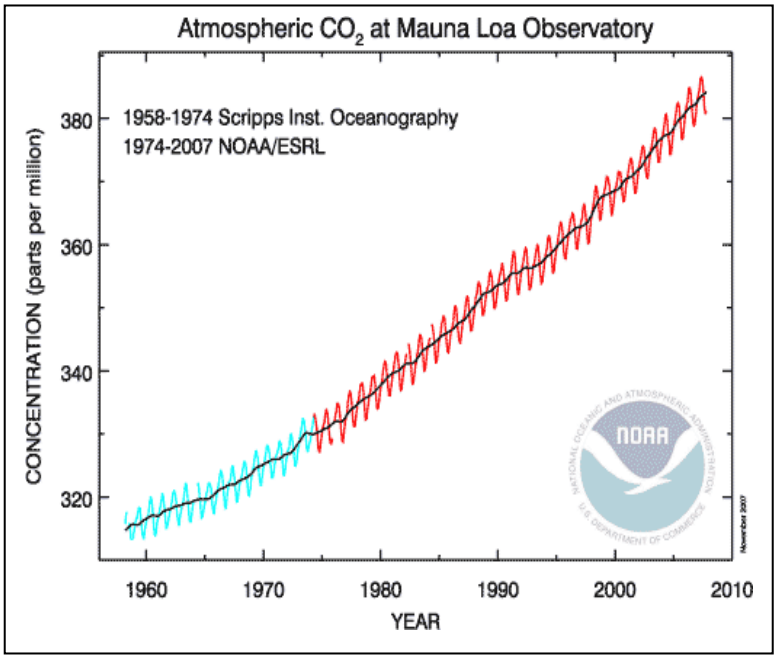
Carbon Dioxide Increases



The Keeling Curve, shown to the left, shows the variation in concentration of atmospheric carbon dioxide since 1958-1974. It is based on continuous measurements taken at the Mauna Loa Observatory in Hawaii under the supervision of Dr. Charles Keeling of the Scripps Institution of Oceanography in San Diego.

Keeling's measurements beginning in 1958, showed the first significant evidence of rapidly increasing carbon dioxide levels in the atmosphere. Additional measurements by scientists working at NOAA have extended the Keeling Curve from 1974-2006.

Atmospheric scientists measure the concentration of gases in terms of parts-per-million (ppm). One ppm = 1 particle out of 1 million particles in a sample. It also represents a percentage: ppm/1million x 100%.

Problem 1 - In the graph, what was the concentration of carbon dioxide in 2005?

Problem 2 - What percentage of Earth's atmosphere, by volume, was carbon dioxide gas in 2005?

Problem 3 - If a concentration of 127 ppm of carbon dioxide in the atmosphere equals a total of 1,000 gigatons of carbon dioxide (1,000 billion tons), about what was the total mass of carbon dioxide gas in 2005?

Problem 4 - How many additional gigatons of carbon dioxide were added to the atmosphere between 1958 and 2005?

Problem 5 - What was the average rate of increase of carbon dioxide gas in gigatons per year between 1958 and 2005?

Problem 6 - The seasonal change in carbon dioxide is shown by the 'wavey' shape of the line. What is the width of this wave (range from maximum to minimum) in ppm, and about how many gigatons does this natural change correspond to?

Answer Key

Problem 1 - In the graph, what was the concentration of carbon dioxide in 2005? Answer: About 379 ppm.

Problem 2 - What percentage of Earth's atmosphere, by volume, was carbon dioxide gas in 2005? Answer: 379 ppm is equal to 100% x 379/1 million = 0.0379 %

Problem 3 - If a concentration of 127 ppm of carbon dioxide in the atmosphere equals a total of 1,000 gigatons of carbon dioxide (1,000 billion tons), about what was the total mass of carbon dioxide gas in 2005? Answer: (379/127) x 1,000 gigatons = 2,984 gigatons, or to 3 significant figures, 2,980 gigatons.

Problem 4 - How many additional gigatons of carbon dioxide were added to the atmosphere between 1958 and 2005?
Answer: In 1958 the concentration was about 315 ppm ,so it gained 379-315 = 64 ppm of carbon dioxide. Since 1,000 gigatons corresponds to 127 ppm, we have (64/127) x 1,000 gigatons = 500 gigatons were added.

Problem 5 - What was the average rate of increase of carbon dioxide gas in gigatons per year between 1958 and 2005? Answer: For the 47 years that span the time interval, there was a 500 gigaton increase, so the rate was 500 gigatons/47 years = 11 gigatons/year.

Problem 6 - The seasonal change in carbon dioxide is shown by the 'wavey' shape of the line. What is the width (range from maximum to minimum) of this wave in ppm, and about how many gigatons does this natural change correspond to? Answer: Using a metric ruler and estimating the peak to peak variation of the amplitude, students should get about 5 ppm as the range. This equals (5 ppm/127 ppm) x 1,000 gigatons = 39 gigatons.