Teaching Activity: Rising Greenhouse Gas Concentrations

Introduction: Carbon dioxide is considered the most important atmospheric greenhouse gas, but it is not the only gas in the atmosphere that influences the Earth's heat balance. Three other very effective infrared heat absorbers are methane, nitrous oxide and chlorofluorocarbons (CFCs). Normally, carbon dioxide, methane and nitrous oxide are added to the atmosphere by natural processes within the Earth system, as well as by human activities. CFCs on the other hand, are completely synthetic. They were introduced for the first time in the 1940's and have been used mainly in refrigeration, air conditioning, foam packaging and other industrial processes.

Three of these gases: CO_2, CH_4 and CFCs account for about 86% of all greenhouse gas emissions. Other greenhouse gases, mainly nitrous oxide, make up the remaining 14%. The amounts of these gases have increased since the early 1800's with the start of the Industrial Revolution. Their concentrations in the atmosphere are measured in *parts per million (ppm) or parts per billion (ppb).* These may sound like extremely small amounts, but in terms of their warming potential it is all that is necessary for them to trap significant amounts of heat energy and eventually cause a rise in the surface temperature of the Earth.

DATA TABLE #1: CONCENTRATIONS OF GREENHOUSE GASES (ppb) 1850-2030

GAS	1850 ESTIMATED AVERAGE CONCENTRATION	1980 MEASURED AVERAGE CONCENTRATION	1990 MEASURED AVERAGE CONCENTRATION	2030 ESTIMATED AVERAGE CONCENTRATION
CO2	260000	338500	353000	450000
CH4	750	1554	1720	2340
N2O	280	296	310	375
CFCs	0	0.49	0.76	3.1

NOTE: 1000 parts per billion = 1 part per million. Thus, the 1990 carbon dioxide concentration was 353 ppm. CFC row shows the total of the 3 most commonly used of these chemicals.

Objective:

- To compute the percent of growth for each of the greenhouse gases for different time segments from 1850 2030;
- To create a line graph showing the percentage of growth from 1850-2030;

Important Terms: Greenhouse gases, CO2, CH4, N2O, CFCs emissions, Industrial Revolution, ppm/ppb,heat energy;

***Materials*.** **Student Activity Sheet**. pencil/paper, graph paper, calculator, ruler colored pencils;

Procedure:

1. Read over and discuss the **Introduction** with the class.

2. Refer to and discuss the **Data Table**. Go through the process for changing the concentrations from ppb to ppm.

   Ex. 234555 ppb --→ 234.555 ppm -> 235 ppm

3. Refer to **Part I** of this activity: **Calculating the Percent of Growth** for each gas.
   - Students will calculate the % of growth for each segment of time and record that information in **Data Table #2**.

   Step #1: Subtract the 1850 amount from the 1980 amount to find the amount of change.

   Step #2: Divide the amount of growth by the 1980 amount.

   Step #3: Move the decimal point 2 places to the right and put a percent sign in its place : .42 = 42%

   - Record the information on the **Data Table #2.**

4. In **PART II**, create a line graph for the concentrations of each of the gases for 1850, 1980, 1990 and 2030 (TOTAL = 4 graphs)
   - Label the Y-axis: Concentration (ppm)
   - Label the X-axis :Year

5. Students should answer the questions in **PART III: Analysis and Comprehension.**

Student Activity Sheet: Rising Greenhouse Gas Concentration

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Objective:

- To compute the percent of growth for each of the greenhouse gases for different time segments from 1850 2030;
- To create a line graph showing the percentage of growth from 1850-2030;

Procedure:

1. Read and discuss the **Introduction** and the **Data Table** with your teacher.
   Be sure that you understand how to change the gas concentrations from ppb to ppm.
   Ex: 234555 ppb -> 234.55 ppm -> 235 ppm

2. Refer to **PART I** on the **Student Activity Sheet #1.**
   - Compute the **Percent of Growth** for each greenhouse gas and record it in **Data Table #2.**

     Step #1: Subtract the 1850 amount from the 1980 amount to find the amount of change.

     Step #2: Divide the amount of growth by the 1980 amount.

     Step #3: Move the decimal point two places to the right and put a percent in its place: .42 = 42%

3. Refer to **PART II** on the **Student Activity Sheet** and create a line graph for the concentrations for each gas for 1850,1980,1990,and 2030.
   - Use a different color for each graph.
   - You should complete 4 different graphs.
   - Label the Y-axes: Concentration in ppm.
   - Label the X-axes: Year

4. Complete the questions in **PART III: Analysis and Comprehension.**

Student Activity Sheet #1

PART I: Calculating the Percent of Growth

DATA TABLE #2: PERCENT OF GROWTH

GAS	1850 -1980	1980-1990	1990-2030
Carbon dioxide			
Methane			
Nitrous oxide			
Chlorofluoro-carbons			

PART III: ANALYSIS AND COMPREHENSION

1. On your CO_2 graph, which segment is steeper, 1850-1980 or 1980-1990? ____________

2. What do you think this change means? ____________________________________

3. How does the segment for 1990-2030 compare to the other segments, is it steeper or is it more gradual? ____________________________________

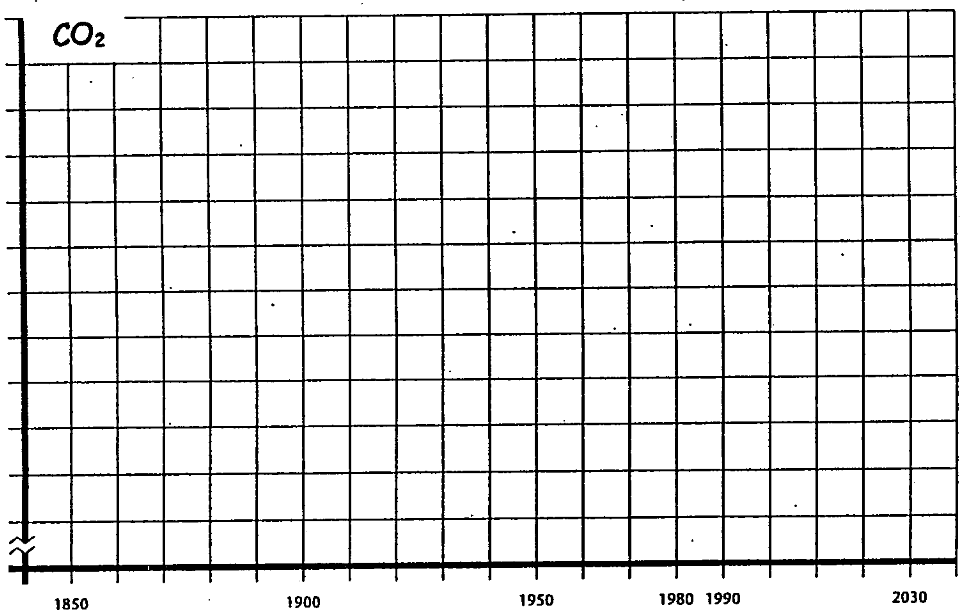
4. What does your answer suggest? ____________________________________

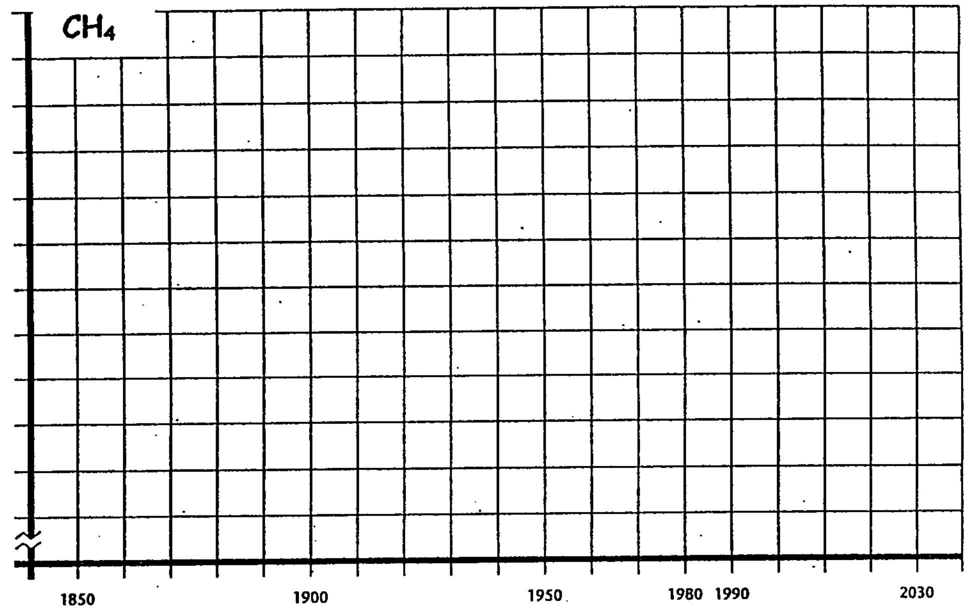
5. Why is this important? ____________________________________

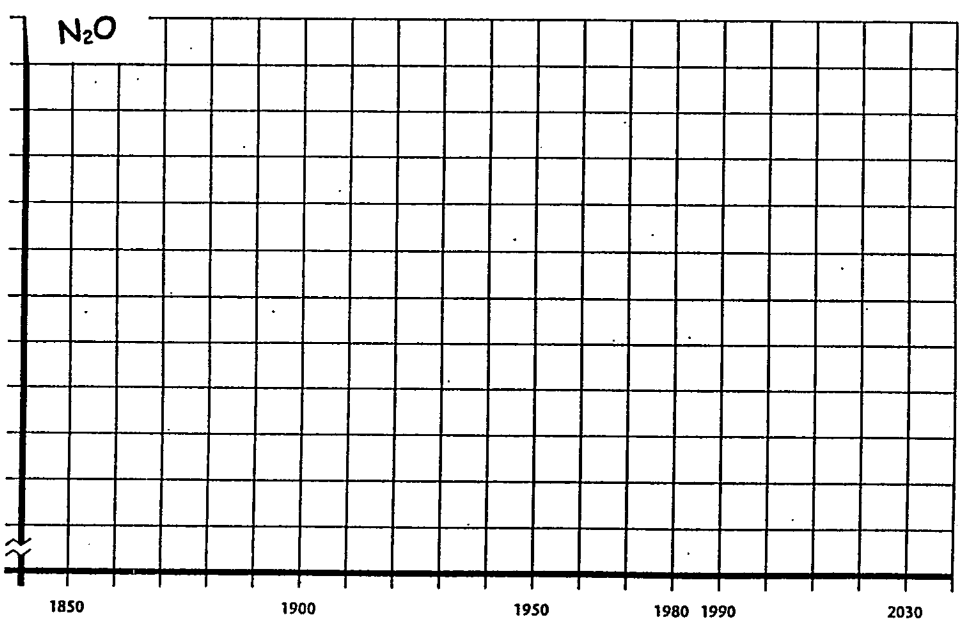
6. What conclusion can you make about the trend in the growth rate of CO_2? ____________

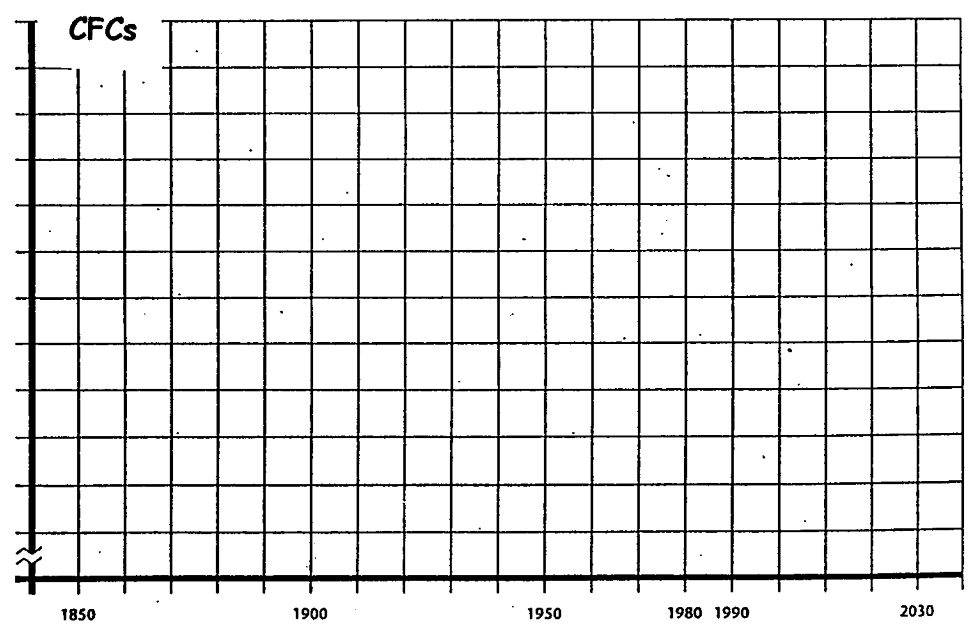
Student Activity Sheet #1

PART II: GRAPH OF GREENHOUSE GAS CONCENTRATIONS









Student Activity Sheet #1:

7. How does the growth for CH_4 compare to that of CO_2? Was it the same, faster or slower? Did it do the same thing for the 1990-2030 segment?

8. The 1850 concentrations of all of the gases are probably similar to what the atmosphere contained prior to the Industrial Revolution. All of the preindustrial concentrations are estimate, except for CFCS. How do we know for certain that their preindustrial concentration was zero?

9. How does the growth rate of CFC's compare to those of CO_2 and CH_4?

10. CFCs have been banned from production and use by international agreement, yet their growth rate does not seen to be greatly affected? Why?

11. What do you think will happen to the segment of a graph for CFCs after 2030, if the international agreements are enforced?

12. Compared to CO_2, the concentrations of the other greenhouse gases appear to be insignificant, yet they are considered to be very efficient heat absorbing gases. What could that suggest about their abilities to absorb infrared heat energy as compared to carbon dioxide?