Teaching Activity: Atmospheric Trace Gases Involved in Global Change

Introduction: The chemistry of the Earth's atmosphere is an important factor in fixing the surface temperature and the conditions for life in general. Although the atmosphere is composed almost entirely of nitrogen and oxygen, other gases that are present in only very small amounts play important roles in the transfer of radiation through the air. The concentrations of many of the most active of these gases are changing rapidly due to human activities.

Objective:

- To create a data table of information on the atmospheric trace gases that are radiatively active and play a significant role in global change;
- To analyze information on specific trace gases and evaluate how it contributes to their role in global change;

Important Terms: Trace gas, atmospheric lifetime, concentration, ppm, pre-industrial, global warming potential, natural/human sources;

Materials: Notes/ research materials on atmospheric gases, copy of **Student Activity Sheet** including blank data table, calculator, paper and pencil;

Procedure:

1. Either present information on atmospheric trace gases in a class lecture/note taking format **OR** make research materials available for students to work on their own.
2. Hand out copies of the blank data table.
   - Go over each of the column headings and explain.
   - Discuss the math process involved in calculating the percent of change for each of the gases.

Step #1: Pre-Industrial Concentration - Present Concentration = Amt. of change

Step #2: Amt. of change ÷ Pre-industrial concentration = Percent of change

NOTE: Per cent of change will be computed as a decimal. Move the decimal point 2 place to the right and insert a percent sign.

   - Instruct students to work on their own and fill in the appropriate information on the data table for each gas.

3. When students have completed the data table, they should answer **Analysis and Comprehension** questions.

ATMOSPHERIC TRACE GASES INVOLVED IN GLOBAL CHANGE

CARBON DIOXIDE (CO_2)

- Major involvement in atmospheric heating;
- Principal human sources are fossil fuel burning and deforestation;
- Balanced in nature: sources equal sinks;
- Exists in the atmosphere for 50-200 yrs.
- 1995 atmospheric concentration about 355 ppm;
- Pre-Industrial Revolution concentrations were about 280 ppm;
- Global Warming Potential of 1;

NITROUS OXIDE (N_2O)

- Major involvement in atmospheric heating;
- Main human sources are fertilizers/ land use changes;
- Natural sources are soils and tropical forests;
- Estimated lifetime in the atmosphere of about 150 years;
- Present atmospheric concentration about .310 ppm;
- Before the Industrial Revolution the concentration about .288 ppm;
- Global Warming Potential of 300;

METHANE (CH_4)

- Major involvement in atmospheric heating; atmosphere;
- Principal human sources are rice culture, cattle, and fossil fuel and biomass burning;
- Principal natural sources are wetlands;
- Can exist for about 10 years in the atmosphere;
- Recorded at 1.72 parts per million in the present atmosphere;
- Before the Industrial Revolution, it's concentration was estimated at about .79 part per million;
- Global Warming Potential of 20;

CHLOROFLUOROCARBONS (CFCs)

- Major contributor to the heating of the Earth;
- Main human sources are refrigerants, aerosol sprays, and industrial foam processes;
- No natural sources;
- Estimated lifetime in the atmosphere between 60-100 years;
- Present amounts are estimated at 0.00028ppm for CFC-11 and 0.00048 for CFC-12;
- Discovered in the mid-1920's; completely man-made;
- Global Warming Potential: CFC-11: 3500/CFC-12: 7300;

Student Activity Sheet: Atmospheric Trace Gases Involved in Global Change

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Objective:

- To create a data table of information on the atmospheric trace gases that are radiatively active and play a significant role in global change;
- To analyze information on specific trace gases and evaluate how it contributes to their role in global change;

Procedure:

1. Refer to the notes that you took in class on the atmospheric trace gases OR use the research material available.
   - Work on your own after listening carefully to the instructions, especially those for computing the percent of change.
   - Fill in the appropriate information on the data table of atmospheric trace gases for each gas.

2. Complete the questions in the **Analysis and Comprehension** section.

Student Activity Sheet #1

DATA TABLE: Atmospheric Trace Gases Involved in Global Change

	CARBON DIOXIDE	METHANE	NITROUS OXIDE	CFCs
Greenhouse Role				
Human Sources				
Natural Sources				
Atmospheric Lifetime				
Present Concentration				
Pre-industrial Concentration				
% of Change				
Global Warming Potential				

Student Activity Sheet #2

ANALYSIS AND COMPREHENSION

1. Which of the four gases on the data table appear to be the largest contributor to global warming? Why? _____

_____

2. How much have each of the gases increased over time?
CO_2_____ CH_4_____ N_2O _____ CFCs_____

3. Why is there information missing on the concentrations and increases for CFCs?

_____

4. Which of the 4 gases is used as the standard for the global warming potential?

_____

5. Even though there is much less methane, nitrous oxide and CFCs in the atmosphere than carbon dioxide, why are these gases of such concern to scientists? _____

_____

_____

6. Why is the lifetime in the atmosphere be a problem if CFCs are no longer being produced? _____

_____

7. Are any of these gases not good absorbers of infrared energy? _____

8. Even if there were no further increases in the atmospheric concentrations of these gases, why would their impact on climate change still be felt well into the next century? _____

_____

9. Scientists know that methane is emitted into the atmosphere by the digestive processes in large grass-eaters, like cattle and sheep, which supply most of the world's meat. How would increased population in developed countries like the U.S. and England contribute to methane concentrations? _____

_____

_____

_____

10. The industrial age appears to have been the start of the increase for all of these gases, except the CFCs. Explain why that is the case. _____

11. What does *global warming potential* mean? _____

12. Explain why CO_2 is said to be *balanced* in nature. _____

13. Trees are large, natural sinks for carbon dioxide and release the stored amount into the atmosphere slowly when they die. Why then, is deforestation such a large source of atmospheric carbon dioxide?

14. One natural source of atmospheric nitrous oxide is soils. Why would agricultural fertilizers containing nitrogen compounds be a problem?

15. Rice paddies produce huge amounts of methane. Why would the region of Southeast Asia have such high regional methane concentrations?

INtroduc***tion:*** The chemistry of the Earth's atmosphere is an important factor in