Name _____ Class _____ Date _____

Skills Practice Lab

MODELING

Concentration of Earth's Greenhouse Gases

Earth's atmosphere is a mixture of gases. About 99 percent of the atmosphere is made up of nitrogen and oxygen. Certain other gases present in smaller amounts are critical to Earth processes. Water vapor and carbon dioxide gas are important in regulating the amount of energy absorbed by the atmosphere. Ozone gas helps control the amount of ultraviolet radiation that reaches Earth's surface. Scientists are particularly interested in measuring changes in the amounts of greenhouse gases, including water vapor, carbon dioxide, methane, and nitrous oxide. These gases occur in such small amounts in the atmosphere that scientists describe their concentration in units of parts per million (ppm), or even parts per billion (ppb). Imagine pouring one can of soda into a large swimming pool, and you are thinking on the order of parts per million. If you can imagine adding one pinch of salt to 10 tons of potato chips, you're thinking on the order of parts per billion!

In this activity, you will dilute a substance to extremely small concentrations. After calculating these concentrations, you will relate the data to the concentration of important gases in Earth's atmosphere.

OBJECTIVES

Describe the meaning of the units parts per million and parts per billion.

Explain why these units are used to describe the concentration of some atmospheric gases.

Create solutions of diminishing concentration.

Compare the concentration of solutions created in the experiment to the concentration of certain atmospheric gases.

MATERIALS

- eyedropper or pipette
- food coloring
- ice cube tray white, or clear plastic trays with white paper underneath
- marker, permanent
- plastic cups, small (3)
- water jug, filled with water

Procedure

1. Use the marker to number the outside of each section of the ice cube tray from 1 to 10. Each section is a "cell" in which you will create a solution with a certain concentration.
2. Fill the three plastic cups about half full with water. The water will be used for cleaning the eyedropper or pipette during the experiment.

3. Put 10 drops of food coloring in cell #1. The concentration of this substance is 1 million parts per million. It represents a pure substance. Write the concentration of this substance as a fraction. Examine how this data has been recorded in Table 1.

_____

TABLE 1: FOOD COLORING CONCENTRATION

Cell Number	Food Coloring Concentration (parts per million)
1	1,000,000
2	100,000
3	
4	
5	
6	
7	
8	
9	
10	

4. Take one drop of food coloring from cell #1 and add it to cell #2. Rinse the dropper in one of the plastic cups until all traces of food coloring are removed. Add 9 drops of clean water to cell #2 and stir. The mixture is now diluted to $\frac{1}{10}$ the concentration of the original substance. The concentration of the new substance is 100,000 parts of food coloring per million parts of solution. Write the concentration of the substance as a fraction. Examine how this data has been recorded in Table 1.

_____

5. Take one drop from cell #2 and add it to cell #3. Rinse the dropper completely. Add 9 drops of clean water to cell #3 and stir. How has the food coloring concentration changed? Record the food coloring concentration of cell #3 in Table 1.

_____

_____

6. Repeat this procedure for cells 4 through 10. Record the concentration of each cell in Table 1.

7. Greenhouse gases affect the temperature of Earth's atmosphere. Study Table 2 on the following page, which shows the concentrations of these gases. Use the information given, as well as the data from Table 1, to determine which of the food coloring cells is closest in concentration to the concentration of each greenhouse gas.

TABLE 2: CONCENTRATION OF GREENHOUSES GASES IN EARTH'S ATMOSPHERE

Gas	Concentration	Cell Number
Carbon dioxide	355 ppm	
Methane	1.7 ppm	
Nitrous oxide	0.3 ppm	
Chlorofluorocarbon-12	0.0005 ppm	
Chlorofluorocarbon-11	0.0003 ppm	

Analysis

1. **Describing Events** What changes did you notice in the color of the solutions you created as you moved from cell #1 to cell #10?

2. **Explaining Events** Some of the solutions created were colorless. Was there any food coloring in those cells? How do you know?

Conclusions

3. **Drawing Conclusions** Imagine that the food coloring in the experiment represents carbon dioxide. What do the water drops added to each cell represent?

Extension

1. **Research and Communication** The concentration of each greenhouse gas in parts per million is incredibly small. How can gases that have such small concentrations have such a large impact on Earth's atmosphere? Use library resources to research one greenhouse gas. In written or oral form, describe the role this gas plays in Earth's atmosphere.