**What Do Concentrations Mean** Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Hour \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Background**

Certain gases, such as the greenhouse gases occur in the atmosphere in miniscule amounts. In a random air sample from the troposphere, for example, you would likely find only about 350 molecules of carbon dioxide for every one million molecules of air mixture. Scientist would express this amount as 350 parts per million(ppm).

Gas concentrations can also be expressed in mass units. With gases in the atmosphere, we usually think in terms of volume and may express this as parts per million by volume (ppmv). Some substances occur in such small amounts that scientists measure them in even smaller amounts such as parts per billion by volume (ppbv) or even parts per trillion by volume (pptv)

Because these measurements are very important to atmospheric scientist, it is useful for people to realize just how important even vanishingly small amounts of certain gases can be. This exercise is designed to give students an appreciation of how many dilutions it takes to achieve a part-per- million dilution of a common substance.

Some interesting comparisons may help to understand how small some part-per-million, billion and trillion dilutions can be.

* 1 30z chocolate bar to a football field. (part per million)
* 1 bad apple in 1,000,000 barrels of apples. (part per billion)
* 1 pinch of salt in 10 tons of potato chips (part per billion)
* 1 postage stamp in an area the size of Dallas, Texas (part per trillion)

**1. Why are we doing this lab?**

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**Materials**

Ice cube tray

Water jug filled with water

Three small plastic cups

Pipette or eye dropper

Food coloring

Marker/colored pencil/crayon

Data chart

**Directions**: In this activity you will explore how many dilutions it takes to achieve a part-per-million dilution of a common substance (food coloring). As you learn more about the concentrations of gases in our atmosphere, think about how these dilutions relate.(You will be working with your table partner)

**Procedure**

1. Fill the three plastic cups about half way full of water. You will use this water to clean your eye dropper.

2. The ice cube tray “cells” are labeled 1-10. In cell #1, place 10 drops of food coloring. This represents a pure substance, or a concentration of 1 million parts per million.

3. Take on drop of the food coloring from cell#1 and place in in cell # 2.

4. Rinse the dropper in one of the plastic cups to remove all traces of food coloring.

5. Add 9 drops of food coloring to cell #2 and stir the mixture. The mixture is now diluted to 1/10th (because there are 10 cells total) of the original concentration, or 100,000 parts of food coloring per million parts of solution.

6. Take one drop from cell #2 and place it in cell #3.

8. Rinse the dropper again.

9. Add 9 drops of clean water to cell # 3 and stir the mixture. How concentrated is the food coloring now? (Be sure to fill out your chart)

10. Your going to repeat the steps for each cell. You add 9 drops of clean water and one drop from the previous cell, mix and determine the concentration. Be sure to clean your dropper between each and fill out your chart.

**Observations and Questions** (*Complete using complete sentences with a restate*)

1. In which cell is the color most intense? Why?

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2. In which cell is the color least intense? Why?

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3. Are there any cells where the liquid is colorless? Is there any food coloring in these cells? How do you know?

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4. Cell #1 contains food coloring with no water added. What is the percent concentration of food coloring for cell #1?

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5. The Earth's atmosphere contains 78% nitrogen which is 780,000 ppm. Which of your cells is closest in concentration in ppm to nitrogen?

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6. The Earth's atmosphere contains 21% oxygen which is 210,000 ppm. Which of your cells is closest in concentration in ppm to oxygen?

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7. Carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons are gases that affect the temperature of the Earth's atmosphere. Their concentrations are listed below. Which of your cells of food coloring is the closest in concentration to each gas? Convert ppm to ppb. ( ppm x 1,000 = ppb)

|  |  |  |
| --- | --- | --- |
| Gas | Concentration | Cell Number |
| CO (Carbon dioxide) | 355ppm = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ppb |  |
| CH (Methane) | 7.1 ppm = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ppb |  |
| N O (Nitrous oxide) | .3 ppm = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ppb |  |
| CFC-11 (CFC) | .0005 ppm = \_\_\_\_\_\_\_\_\_\_\_\_\_ppb |  |
| CFC-12 (CFC) | .0003 ppm = \_\_\_\_\_\_\_\_\_\_\_\_\_ppb |  |

9. How does the concentration of the greenhouse gases compare to the concentration of oxygen and nitrogen?

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10. How can gases such as carbon dioxide and methane, with their small concentrations, have such a large effect on our atmosphere? Give this question your best effort, use the internet if needed.

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