Teaching Activity: Now What's A Billion?

Introduction: When an atmospheric chemist is studying the constituents of the Earth's atmosphere, he is dealing with very tiny amounts of molecules within a large sample of air. His results will generally be expressed as either parts per billion (ppb) or parts per million (ppm). For example, a notation of 50 ppm of lead means that for every 1 million parts of air studied, 50 of those parts are lead. If the notation were 300 ppb of carbon, it would mean that for every one billion parts studied, there were 300 that were carbon. A part of a million or a part of a billion is a difficult concept to visualize. The activity that follows will help students to form a picture in their minds of exactly what a million or a billion parts of anything would be equal to.

Objectives:

- To provide a visual model of the specific units (millions, billions, etc.,) used in the measurement of the abundance of gas species in the atmosphere;

Materials: Activity sheet, paper and pencil, ruler,and calculator;

Procedure:

1. Students should count the number of dots on the handout and record that number.

2. Using the information acquired in #1, students should then calculate how many pages they would need to make 1 million dots.
   - Students should explain in written form how they arrived at that answer.

3. Using the information acquired in #1 and #2, students should then calculate how many pages it would take to make 1 billion dots.
   - Students should again explain in written form the process they used to arrive at that answer.

4. Students should then complete the answers to the questions in the **Analysis and Conclusions** section.

Student Activity Sheet: Now What's A Billion?

Background: When an atmospheric chemist is interested in the constituents in the
Earth's atmosphere, he is dealing with very tiny amounts of molecules within a large
sample of air. His results will generally be expressed as either parts per million or
parts per billion. For example a notation of 50 ppm of lead means that for every 1
million parts of air studied, 50 of those parts are lead. If the notation were 300
ppb of carbon, it would mean that for every 1 billion parts studied, there were 300
that were carbon. A part of a million or a part of a billion is a difficult concept to
visualize. The activity that follows will help you to form a picture in your mind of
exactly what a million or a billion parts of anything would be equal to.

Objectives:

- To provide a visual model of the specific units (millions, billions, etc) used in the
measurement of the abundance of gas species in the atmosphere;

Materials: Lab sheet, paper and pencil, ruler and calculator;

Procedure:
1. Count the number of dots on the handout. Record that number. _____

2. Using the information you acquired in #1, calculate how many pages you would
need to make one million dots. Explain the process you used to arrive at that
answer in the space below. Record your answer. _____

3. Using the information you acquired in #1 and #2, calculate how many pages it
would take to make 1 billion (1,000,000,000) dots. Explain the process that you
used to arrive at that answer in the space below. Record your answer.

_____

Analysis and Conclusions:

1. If in each inch there are 250 pages, how many inches of paper would it take to
make a total of one million dots? _____

2. How many inches would it take to make a total of 1 billion dots. _____

2. How many inches would it take to make a total of 1 billion dots. _____

3. How any feet would it take to make a total of 1 billion dots? _____

4. There are approximately 5.5 billion people in the world today. Each dot represented one person, how many pages would be necessary to show the population of the world? _____

5. How many inches of paper would represent the population of the world with dots? _____ How many feet? _____

6. If there are 12 feet per story of a downtown office building, how tall of a building would be represented by this stack of paper?

Answers: _____ inches _____feet _____stories

7. In a sample of air scientists took from an ice core in Greenland, they identified 250 molecules of nitrous oxide for every 1 million molecules of air. What would be the notation for that amount? _____ What would the notation be if there were a total of 1 billion molecules in the entire sample?
_____

8. Explain what a notation of 280 ppm of carbon dioxide means.

9. Explain what a notation of 1700 ppb of methane means.

10. A notation can be changed from ppm to ppb by moving the decimal to the left the correct number of spaces. For example, 1700 ppb would be 1.7 ppm by moving the decimal point 3 places to the left. If you were converting from ppm to ppb the decimal place would be moved 3 places to the right. So, 5.0 ppm would become 5000 ppb. Change the values below from ppm to ppb, and from ppb to ppm by moving the decimal point either left or right.
   a. 2300 ppb _____
   b. 11.5 ppm _____
   c. 1500 ppb _____
   d. 280 ppm _____
   e. 450 ppm _____
   f. 4.5 ppm _____
   g. 19000 ppb _____
   h. 125 ppm _____
   i. 155000 ppb _____
   j. 567 ppm _____