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## Concentration is Essential for this Task!: An Activity in Comparing of Concentrations

STORM Project

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## Middle Level Science

### Concentration is essential for this task!

An Activity in Comparing of Concentrations

#### Objectives:

Students will be able to explain and give examples of both parts per million and parts per billion. In the next activity students will use these values in the analysis of air quality data.

#### National Science Education Standards:

Earth materials are solid rocks and soils, water, and the gases of the atmosphere. The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel, or for growing the plants we use as food. Earth materials provide many of the resources that humans use.

Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.

Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.

#### Teacher Background:

Prior to the introduction of criteria pollutants and NAAQS values, it may be helpful to familiarize students with the scale at which criteria pollutants have been deemed harmful. Often numbers as small as these can seem almost abstract, but the following activities will help to make them accessible and concrete to the students, making the discussions of NAAQS values more meaningful.

#### Related Terms:

ppm – parts per million

ppb – parts per billion

ppt – parts per trillion

pollution

density

volume

qualitative

quantitative

#### Major Concepts:

composition of air

concentration

## Engage:

Challenge students to write from 1 to 1,000,000 on paper. See if there are any takers for this challenge. I always agree to take them and two of their best friends out to any restaurant in the area if they will write from 1 to 1,000,000 making sure they write every single number by hand. They must also work alone. Set a completion date about 2-3 months away.... this will be very safe.

After asking for volunteers, give them an opportunity to back out by showing them the following information.

“Between 1 and 1,000,000 there are 9 single digit numbers (1-9), 90 two digit numbers (10-99), 900 three digit numbers (100-999), 9000 four digit numbers (1000-9999), 90,000 five digit numbers (10,000-99,999), 900,000 six digit numbers 100,000-999,999 and 1 seven digit number (1,000,000).”

“Notice that 90% of the numbers have six digits.”

Have the students do the following. “Write down this number (can be any six digit number) **257,800**”. “When I say begin write down the next number in sequence (257,801, 257,802 ....) and so on as fast as you possibly can”. “I will time you for 20 seconds”.

Say go and stop after 20 seconds. Check to see who has the most consecutive numbers written. Multiply this number by 3 and that will be how many numbers they could write in 1 minute. Multiply that number by 60 and determine the most numbers that could be written in 1 hour. Multiply by 24 for to see how many could be written in one day. And finally divide this total into 1,000,000 to determine how many days it will take.

Explain that that this would be continually writing as fast as possible (the fastest student’s rate) continuously without a break (bathroom, eating, sleeping, talking on the phone etc).

See if any students still want to take the challenge. A few may linger but please encourage them to think it through. Explain that this is a good example to show how large a number 1,000,000 really is. You can then relate this to parts per million and other really large or small numbers we often times encounter.

Explore:

**“You’re One in a Million”**  
An Activity in Comparison of Concentrations

1. Look at your stack of 10 pennies. What would the mass of this stack be in grams? How much mass do you think 1,000,000 pennies would have in grams? In Kilograms?
2. Look at your stack of 10 cards. How tall do think that this stack is in centimeters? How tall do you think a stack of 1,000,000 cards would be in centimeters? In meters?

**Steps:**

1. Place 10 pennies on the balance beam. Record the mass in the \* box. What is the mass of one penny? Use this mass to calculate the mass of 1,000,000 pennies in grams. Then divide this number by 1,000 to calculate the mass in Kilograms.

No. of pennies	1	10	100	1000	10,000	100,000	1,000,000
Mass in grams		*					

Mass of 1,000,000 pennies in Kilograms= \_\_\_\_\_



2. Stack the 10 cards and use a ruler to measure the height of the 10 cards in centimeters. Record the height in the \* box. What is the height of one card? Use this measurement to calculate the height of 1,000,000 cards in centimeters. Divide this number by 100 for meters and that value by 1000 for kilometers.

No. of cards	1	10	100	1000	10,000	100,000	1,000,000
Height in centimeters		*					

Height of 1,000,000 cards in Meters = \_\_\_\_\_ in Kilometers= \_\_\_\_\_



Elaborate:

**Activity – Serial Dilution Lab**

**Preparing a 1 part per million solution**

**Materials** (students work in groups of 2, 3, 4)

7 small paper cups or test tubes, food coloring, water, eye dropper,

**Procedure:**

Label the 7 cups in the following manner:

Cup #1 = 1    Cup #2 = 1/10    Cup #3 = 1/100    Cup # 4 = 1/1000    Cup # 5 = =1/10,000

Cup # 6 = 1/100,000    Cup # 7 = 1/1,000,000

Place 3-4 drops of food coloring in cup #1, using the eye dropper place 9 drops of water into cups #2 - # 7. Place one drop of food coloring in cup # 2 and mix with stir rod. Now take one drop from this new solution in cup # 2 and place it into cup # 3. Again mix the solution and place a drop into the cup. Repeat this procedure until you reach cup # 7. The concentration of food coloring in cup # 7 is 1 part per million in water (1 ppm).

What would you need to do to make a concentration of 1 part per billion (1 ppb)?

Evaluate:

**The Million Project** – (Interdisciplinary opportunities)

On a single sheet of plain typing paper, students will describe one million identical objects in terms of volume, mass or length.

Students must provide an example of what one million identical objects would look like when placed together. An example would be how far would 1,000,000 dollar bills stretch if placed end to end. If each dollar bill is 6 inches long the trail of dollar bills would stretch 6 million inches. This is still too large number but if we convert inches into feet this would be equal to (6,000,000 divided by 12) 500,000 feet or (500,000 divided by 5280) 94.7 miles.

Putting this into a real world perspective imagine what it would look like if you drive along a highway for about 95 miles and see dollar bills laid end to end the entire way. To see what 1 part per million looks like picture one of these dollar bills marked with a big X. This one dollar bill would be 1 in one million of these dollars or 1 ppm.

Encourage students to use a variety of objects and to be original. For example, stacking dollar bills instead of laying end to end or how much space do 1,000,000 ping pong balls take up? or how much space do 1,000,000 drops of what take up? or how long would it take to play a 2-minute song a million times? Encourage originality.

**The one-page paper must include:**

- An explanation neatly typed or written in ink on a single plain colored page. (minimum one paragraph)
- A drawing, picture or example of the object you are using in the project. (e.g., baseball card, dollar bill, gum wrapper, picture of a ping-pong ball)
- Show calculations and conversions (e.g., inches to feet to miles etc.)
- Project must be neat and checked for proper spelling and grammar.

One possibility is to have the math instructor and/or classes check the mathematical calculations for accuracy; the English instructor and classes check for spelling and grammar and the art instructor look over the artistic portion of the project. The art department is always helpful in giving students ideas for their drawings and presentations.

Assemble all of the student pages into a book for student to observe and review.