Science Corner

HOW MUCH IS ONE-IN-A-MILLION, REALLY?

Sometimes small amounts can make a big difference, like the amount of chlorine needed to keep a swimming pool clean or nutrients needed in soil to grow healthy crops. Small concentrations are often measured in parts per million (ppm). A million is a large number and can be hard to visualize. This experiment is intended to demonstrate how small 1 ppm is and help to explain laboratory detection limits.

1 ppm is like:

- A few drops of dye in a bathtub
- One minute out of two years
- One grain of salt in a sack of sugar

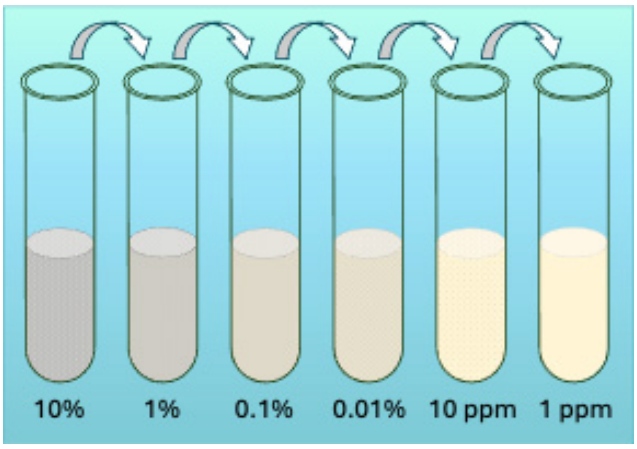
MATERIALS:

- **Flour** *1 1/8 cups*
- **Vinegar** *9-18 mL (about 3 tsp)*
- **Measuring Spoons** *teaspoon*
- **Baking Soda** *1 tsp*
- **Mixing Bowls** *7 (cereal bowl size)*
- **Dropper** *2-3 mL (about 1/2 tsp)*

PROCEDURE:

We will be making different concentrations of flour and baking soda mixtures. When baking soda is mixed with vinegar, it reacts by releasing bubbles of carbon dioxide. But flour does not react with vinegar. We will add vinegar to each mixture to see how much reaction is visible for different concentrations.

Start by adding 1 part baking soda (1 teaspoon) with 9 parts flour (9 teaspoons) to a bowl and mix well. This is now a 10% or 100,000 ppm baking soda mixture. If you take 1 part of this 10% mixture and mix it with 9 parts flour, it makes a 1% or 10,000 ppm mixture. You can repeat these steps in a method known as serial dilution to get lower concentration mixtures.



Parts per million (ppm)	100,000	10,000	1,000	100	10	1
Percent	10%	1%	0.1%	0.01%	0.001%	0.0001%
Fraction	1/10	1/100	1/1,000	1/10,000	1,100,000	1/1,000,000

OBSERVATIONS:

Now take a ¼ teaspoon sample of each mixture in a separate container and add 2 mL (~½ teaspoon) of vinegar. Observe and record what happens:

Sample A: ___%/ _____ppm

_____

_____

_____

_____

_____

Sample B: ___%/ _____ppm

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_____

_____

_____

_____

Sample C: ___%/ _____ppm

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CONCLUSIONS:

Record below what you learned from this experiment.

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WHY THIS MATTERS:

One part per million is a tiny amount, but sometimes tiny amounts matter – substances present at parts per million or even smaller concentrations may be important. This is why laboratories use specific procedures and instruments designed to detect very small concentrations for the substance of interest. A laboratory can show their results are accurate by reporting the correct result for a sample where the actual concentration is known. They can show their results are precise by repeating the test multiple times and getting the same results.

Laboratory instruments have detection limitations. The detection limit is the lowest concentration the instrument can reliably see. When a laboratory cannot detect a substance in a sample, the result is labeled with a "U" for undetected. The laboratory also reports the instrument detection limit for the substance. If a result is labeled with a "U," that doesn't mean the substance isn't there, it just means that the instrument didn't detect it. For example, when we test for baking soda with vinegar, what is the estimated detection limit for this method? (**Hint**: What is the lowest concentration mixture where bubbles were seen?)

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