BioS.I.T.E Kit Materials Card

# Parts Per Million

"How Much is a Million?" book

10 Liquid food coloring vials

30 plastic divot trays

30 clean water cups

30 rinse water cups

30 droppers

30+ round filter papers

30+ toothpicks

# Parts Per Million

**Content**

Just as super large numbers are important to understand and be able to use- so are super small numbers! Very small amount of elements, salts, and metals are essential to life on earth. Very small amounts of certain elements, salts, and metals can also contribute to problems for our planet, by causing air and water pollution. Monitoring air quality and water quality is a science that deals with measuring very small numbers of pollutants to ensure healthy air and water for all.

Concentrations of chemical pollutants in water are frequently expressed in units of parts per million (ppm) or parts per billion (ppb).

| Unit | 1 Part per Million | 1 Part per Billion | 1 Part per Trillion |
|---|---|---|---|
| **Length** | 1 inch per 6 miles | 1 inch per 16,000 miles | 1 inch per 16,000,000 miles |
| **Time** | 1 minute per 2 years | 1 second per 32 years | 1 second per 320 centuries |
| **Weight** | 1 ounce salt per 31 tons of potato chips | 1 pinch salt per 10 tons of potato chips | 1 pinch salt per 10,000 tons of potato chips |

For example, chemical fertilizers contain nitrate, a chemical that can be dangerous to infants in quantities as small as 10 parts per million. Trichloroethylene (TCE), a common industrial solvent, is more dangerous than nitrate and when present in drinking water in quantities as small as 5 parts per million can
cause a higher than normal incidence of cancer among people who drink the water regularly.

| | | | |
|---|---|---|---|
| **Arsenic** | 0.01ppm | Skin damage, circulatory system damage, cancer | Found underground naturally; runoff from orchards or glass and electronics manufacturing. |
| **Atrazine** | 3ppb | Heart, muscle, and reproductive problems. | Runoff containing herbicides. |
| **Benzene** | 5ppb | Anemia, cancer | Runoff from factories; gasoline leaks. |
| **Chlorine** | 4ppm | Eye/nose irritation, stomach discomfort | Added to water on purpose to control microbes. |
| **Mercury** | 2ppb | Kidney damage | Found underground naturally; runoff from factories or landfills. |
| **Nitrate** | 10ppm | Infants can become seriously ill and die. | Runoff containing fertilizer or sewage. |

BioSITE **Kit Activity Card**

# Parts Per Million

*Students will experiment with food coloring and water to prepare a solution demonstrating 1 part per million and 1 part per billion.*

## Guiding Questions

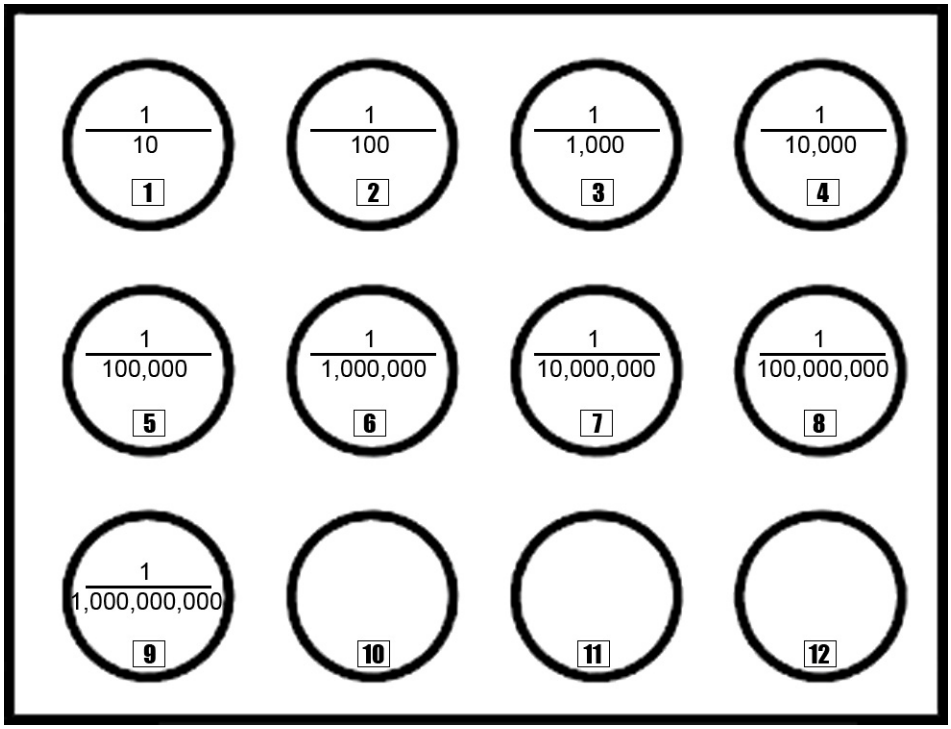
Spend some time writing and saying numbers with zeros- 10, 100, 1,000, and make sure students understand the meaning of each. Then ask students if they know how many pennies equal one dollar. How do they know? (10 x 10= 100) Then ask if they know how many pennies would equal one million dollars (100 x 1,000,000 = 100,000,000). Ask them if they think they could count that many pennies into their penny bank! Large numbers are amazing—and confusing!

Read aloud the "How Much Is A Million" book. Students will be amazed at the comparisons, and you can choose one or two explanations from the back of the book to help them understand more about the super large numbers! Talk to students about number systems and why this makes it easier for us to use super large numbers. One million is easier to say than count!

## Set-up

Give each station a divot tray, dropper, toothpick, filter paper, paper towels, clean water cups, rinse water cups, and vials of food coloring.

Draw an example of the white tray on the board and label each divot with a number.



## Activity

1) Have each student place ten drops of food coloring into divot #1. This food coloring solution is one part dye to ten parts water. Write 1/10 on the board.

2) Have students rinse the dropper in the rinse water cups and take one drop from #1 and place it in #2. Then, add nine drops of clean water into #2. Use the toothpick to stir the solution. Explain how this changes the 1/10 solution to a 1/100 solution (1/10 x 10 = 1/100). Write 1 part per 100 (1/100) on the board.

3) Repeat this procedure for #3, #4, #5, and #6 to get to 1/1000 (one part per thousand or PPT), 1/10,000, 1/100,000 and 1/1,000,000 (one part per million or PPM). Have students work carefully and rinse the dropper and toothpick each time they move between solutions.

4) When you get to #6 take a moment to talk about how each divot looks. Ask students in which solution do they no longer see any sign of blue food coloring.

5) Further experiment by having students put drops from each divot onto filter paper using a toothpick. Ask students if they see any evidence of blue coloring present on the paper from divots which appear to be clear.

6) You can continue the procedure to demonstrate parts per billion (PPB). Remind students how many 1,000,000,000 is.

7) Finally, ask students if each solution has food coloring in it. Even the clear-looking ones? How do they know? Many variables in water are measured with these units- so we can measure very small amounts!

## Challenge

Find out about other units of measure. Make a list of all the different units of measure you can find- they are everywhere! 1 cup, 1 pound, 1 meter, 1 ppm, 1 minute, 1 acre, etc.