

3

Concentration



Parts per Million

In the last activity, you found that there were concentrations of powdered drink mix that you couldn't see, smell, or taste, but you didn't know exactly what the concentrations were. In this activity, you will find a way to describe the amount of food coloring in a solution if the amount is very, very small.

CHALLENGE



Use parts per million to describe the concentration of a solution. You will also be learning to perform a serial dilution, a procedure you will use many times in the activities.



MATERIALS



For each group of four students:

- 1 30-mL dropper bottle of red food coloring (10% solution)

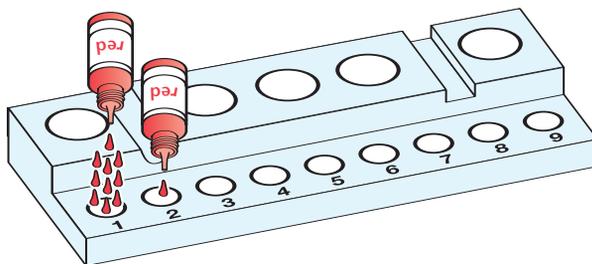


For each pair of students:

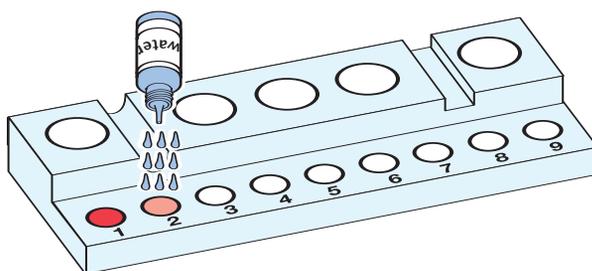
- 1 SEPUP tray
 - 1 dropper
 - 1 30-mL dropper bottle of water
- Student Sheet 3, "Serial Dilution Template"

PROCEDURE

1. Place the Student Sheet 3, "Serial Dilution Template," under the SEPUP tray.
2. Put 10 drops of 10% red food coloring into small Cup 1 and put one drop into small Cup 2, on the lower level of your SEPUP tray.

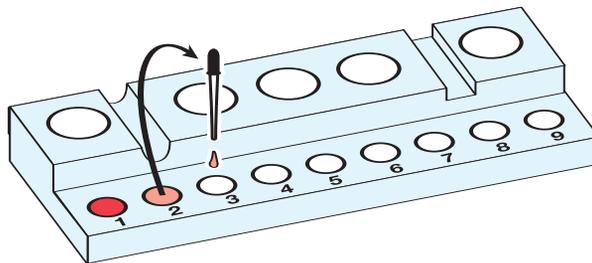


3. To small Cup 2, add 9 drops of water. Mix the solution by drawing it up into the dropper. Then gently squeeze the bulb until the dropper is empty, carefully putting the liquid back into Cup 2.

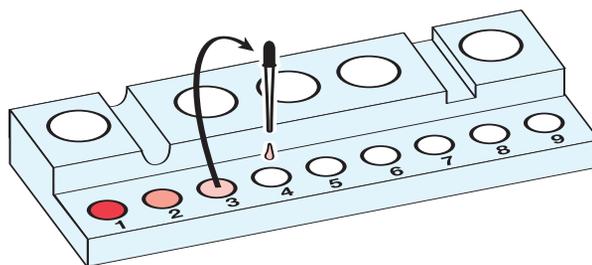
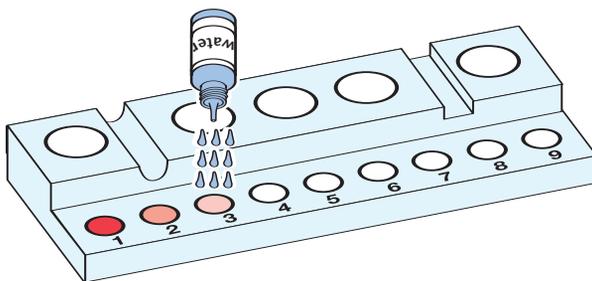


Activity 3 • Concentration

4. Using the dropper, transfer one drop of the solution in Cup 2 to Cup 3. Return any excess to Cup 2.



5. Add 9 drops of water to Cup 3. Use the dropper to mix the solution in Cup 3, and transfer one drop to Cup 4. Return any excess to Cup 3.



6. Add 9 drops of water to Cup 4. Mix. Transfer one drop to Cup 5. Add 9 drops of water to Cup 5. Mix.
7. Continue the process through Cup 9, each time taking a drop of the solution from the previous cup and adding 9 drops of water.
8. Record the color of the solution in each cup in a data table in your science notebook. A sample data table is shown on page A-19.
9. Determine the concentration of the solution for each cup as a part of food coloring per amount of solution, and record it in your data table.
10. Answer the Analysis questions.

Serial Dilution

Cup	Color	Concentration (parts of dye per parts of solution)	
		parts per ____	%
1		1 part in 10	10%
2		1 part in ____	
3		1 part in ____	
4			
5			
6			
7			
8			
9			

ANALYSIS

1. Which is more dilute, Cup 1 or Cup 2? How do you know this?
2. If Cup 1 has a concentration of one part in 10, and Cup 2 has 1/10 the concentration of Cup 1, what is the concentration of Cup 2?
3. Which cup has a concentration of one part per million?
4. What is the number of the cup in which the solution first appeared colorless? What is the concentration in parts of food coloring per parts of solution in this cup? (Express the answer for concentration as one part per ____.)
5. What are the possible reasons for student differences in reporting the cup in which the solution first appeared colorless? (**Hint:** Consider the idea of threshold.)
6. Do you think that any of the food coloring is present in this cup of diluted solution even though it appears colorless? Explain.

7. Explain how you could do an experiment to prove that there is actually some red food coloring in this cup.
8. How would you explain what a million is to a young child?
9. If you change the solution of food coloring in Cup 1 from one part in 10 (10%) to five parts in 10 (50%), what would the concentration of the food coloring be in Cup 6?



Some Interesting Comparisons

Now that you've spent some time trying to understand or picture just what one in a million (or even one in a billion or one in a trillion) means, here is a short list of comparisons.

CHALLENGE

Can you think of a one in a million comparison yourself?

- One part per million is one second in 12 days of your life.
- One part per billion is one second in 32 years of your life.
- One part per million is one penny out of \$10,000.
- One part per billion is one penny out of \$10,000,000.
- One part per million is one pinch of salt on 20 pounds of potato chips.
- One part per billion is one pinch of salt on 10 tons of potato chips.
- One part per million is one inch out of a journey of 16 miles.
- One part per billion is one inch out of a journey of 16,000 miles.
- One part per million is approximately one bad apple in 2,000 barrels.
- One part per billion is approximately one bad apple in 2,000,000 barrels.
- One part per billion is one square foot in 36 square miles.
- One part per trillion is a postage stamp in an area the size of New York City.