# Testing Water Samples



**Activity Description & Estimated Class Time**

Over the course of three 50-minute class periods, students will understand the idea that contaminants may be in water in small quantities that are not detected by the human eye, but are indeed present, and have an impact. They will also test water from four local sources to determine its purity.

**Correlations to NC Science Standards**

ESS.8.3.1 Analyze and interpret data to predict the safety and potability of water supplies in North Carolina based on physical and biological factors, including: temperature, dissolved oxygen, pH, nitrates and phosphates, turbidity, and bio-indicators.

**Learning Target**

Students will demonstrate knowledge and understanding that as the 'universal solvent' water dissolves lots of things, including some things that make it less useful for washing and drinking.

**Brief Science Background**

Another of water's unique properties caused by its polarity is its ability to dissolve many things. Water is called the 'universal solvent' for this reason; however, it doesn't dissolve everything. An example is that water may dissolve a small amount of the copper pipes that carry it through the school or a home. The amount of copper, or anything else dissolved in water, is commonly measured in "parts per million." Even though a million is a very large number, it is hard to imagine what this might look like in water. Would the particles be visible? Could they be tasted? Would they be harmful if ingested? Contaminants may be in water in small quantities that are not detected by the human eye but are inded present, and have an impact.

As the 'universal solvent,' water dissolves lots of things, including some things that make it less useful for washing or drinking. Some water impurities can even corrode pipes. Common measures of dissolved compound include 'hardness' (calcium and magnesium salts), acidity or alkalinity (low or high pH), chlorine (added to kill bacteria), iron, copper from pipes, or coliform bacteria. Although a particular type of coliform bacterium may not be dangerous, the presence of coliform bacteria in a water sample indicates that other potentially dangerous organisms may be present. Any sample that tests positive for bacteria should not be consumed.

EPA recommendations for limits on water contamination are summarized below:

- Alkalinity - should be < 180 ppm
- pH - should be between 6.5 and 8.5
- Hardness - should be < 50 ppm
- Iron - should be < 0.3 ppm
- Copper - should be < 1.3 ppm
- Total Chlorine - should be < 4 ppm

# Part 1 — Parts Per Million

## Materials

**Materials for the whole class demonstration**

- 1 dropper bottle of 10% red dye solution
- chemplate
- sheet of white paper (provided by teacher)

**Materials for groups of 4 students**

- student activity sheet (SD 1)

## Procedure

1. Remind students that water is the universal solvent and that many different things are dissolved in water, even the water we drink. Ask students to brainstorm why it might be important to measure the amount of things dissolved in water.
   Accept all answers at this point.
2. Next, ask students to brainstorm how much of something might be dissolved in water.
   Accept all answers at this point.
3. Let students know that today's demonstration will explore how many particles might be dissolved in water and how it could be detected. Ask students to put these numbers (1 million, 1 thousand, 1 hundred, and 1) in order from smallest to largest on their student activity sheet (SD 1). Ask students to write the numbers out in numerical form (1, 100, 1,000, 1,000,000.)
4. Now ask students to write out the fraction form for one tenth (1/10) one one hundredth (1/100), one one thousandth (1/1000), and one one millionth (1/1,000,000). Discuss with students which of the fractions is the largest.
   If they need a hint, ask the question as which fraction is closest to 1 on the number line. The answer is 1/10.
5. Have students put the fractions in order from largest to smallest on their student activity sheet. (1/10, 1/100, 1/1000, 1/1,000,000).
6. Tell students that these fractions are ways to indicate how many particles are dissolved in water. The numerator represents the amount of dissolved particles and the denominator is the amount of water.
7. Tell students that they are now going to help you with a demonstration of this idea. Put a chem plate on a sheet of white paper under the document camera, or other display device. Put 5 drops of red dye in the oval space of the chem plate. Tell students this represents the material to be dissolved in water.
8. Now ask students "how we could make a 1/10 mixture of red dye and water?" Most will say 1 drop red and 10 drops water. If they do, ask how many total drops that would be (11) and how many total drops does our fraction call for (10). Students should then realize that a 1/10 mixture is 1 drop red and 9 drops water. **Make this solution in well #1**. Stir carefully. Have students record the appearance of the solution on their data sheet and the dye/water fraction (1/10) on their sheet. Ask students to write out the parts per designation (part per ten) on their sheet.
9. Now, let students know you will put **one drop from well #1 and 9 drops water into well #2.** Challenge students to figure out what the fraction would be. Take answers from students, asking them to explain their thinking. The answer is 1/100. Next, ask students to write the parts per designation (parts per hundred) and to describe the appearance of the liquid in the well.

**Procedure cont.**

10. In well #3, put in one drop from Well 2 and 9 drops of water. Again ask students to observe the liquid, write out the fraction and the parts per designation. It is 1/1000 and parts per thousand.
11. Continue this procedure through well #7.
    By this point no dye will likely be visible. Some of the parts per designations will be artificial, like parts per ten thousand, but they are still valid and help students to understand the concept of concentrations.
12. After discussing results for wells 4-7, ask students to predict which well would show parts per billion. Have students write out the fraction and provide their thoughts on what the appearance would be.
13. To conclude the activity, have students complete questions 4-7 on their student activity sheet (SD 1).

**Content Connection**

1. Discuss students' responses to questions 4-7 from their student activity sheet (SD 1).
   Questions 4-6 help to assess student understanding of the ideas of concentration and that not all contamination may be observable. Question 7 prepares students to understand the importance of testing for water quality.

## Part 2 — Testing Water Samples

**Materials**

**Materials for the whole class demonstration**

- 4 sterile collecting bottles for collecting water samples
- 4 water samples in bottles from different locations, labeled by location (provided by teacher)

**Materials for groups of 2 students**

- 2 test strips of the following:
  - hardness
  - pH
  - chlorine
  - iron test
  - copper
- 1-oz cup or water sample labeled with location from which it was taken. **Each group should get 2 different water samples.**
- 1 empty 1-oz cup to be used to collect used test strips
- 1 water analysis test instructions sheet
- 2 testing water samples student activity sheets (SD 2)
- paper towels (supplied by teacher)

**Preparation**
**allow for 30 min.**

1. Collect water samples from four different locations. Try to include samples from outdoors, such as a pond or stream, and some from drinking water sources. Take care when collecting samples not to pollute them by touching the inside of the cap or bottle. Do not let your hand touch water that may go into the collecting bottle. Label each location on the bottle.
2. Pour the water samples into 1 oz cups and label the cups with the location from which it was taken. Make enough so that each group of two will get 2 different water samples.

## Procedure

1. Tell students that today they will take the role of water quality specialist and collect data on water from different locations. Discuss with students what they know about water quality, who sets the standards for water quality (EPA), and how concentrations of contaminants are measured (parts per million - ppm - most often).
2. Let students know there are a total of four samples to be tested but each group will only test two. Once testing is complete, the class will share data so it is very important to collect the most accurate data possible.
3. Review the notes about testing, procedures, and EPA recommendations found on the testing water samples student activity sheet (SD 2).
4. Remind students of safe handling procedures. **Never drink any of the water and only touch the ends of the test strips.**
5. Model for students how to do a sample test. Demonstrate handling the strip, reading the directions, dipping, swirling, and comparing the colors.
6. Distribute supplies for testing and allow students to begin. Monitor their testing. Be sure they are recording data accurately on their student activity sheet.

## Content Connection

1. After testing is complete, share data as a class. Discuss any discrepancies and possible causes for them. Discuss the results and what was revealed about the quality of the water samples.
2. Have students complete the data analysis and personal reflection portions of the student activity sheet.

SD 1

# Parts Per Million Student Activity Sheet

Name:

1. Write the whole numbers your teacher shares in order from least to greatest.

2. Write the fractional numbers your teacher shares in order from greatest to least.

3. Complete the chart below.

| Well # | Fraction | Parts Per _____ | Visual Description |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

4. Which well would represent parts per billion?

5. Which well has more contaminant, #3 or #5? How to you know?

6. Is there contaminant in well #7? What evidence supports your answer?

7. Why might it be important to test for contaminants in very small amounts in water samples?

# SD 2 - 1 of 2 Testing Water Samples Student Activity Sheet

Name:

**Procedure**

Notes to students about test strips:

These tests are very sensitive, so be careful not to touch anything that comes in contact with your sample. Note the following with these test strips:

- Each strip can be **used only once**.
- Follow directions on the **water analysis test instructions sheet** for each test strip.
    - Pay attention to how long you dip the strip in the sample before removing it.
    - Hold the strip level (parallel to the floor).
    - Read the results after the amount of time specified.

**Do the following steps in this order:**

1. Read the directions for each test strip now. **DO NOT open the test strips yet. Ask any questions now.**
2. Test the sample **1-test-at-a-time.** Record the name of the sample (location from which it was taken) and your results in ppm on page 2. Do all of the following tests, and record the results of each in ppm. After each test, place the used strip in the empty 1-oz cup.
    - pH test strip
    - hardness test strip
    - iron test strip
    - copper test strip
    - chlorine test strip
3. Use the EPA recommendations for limits of water contamination below to note whether you think any action could be taken.
    - pH - should be between 6.5 and 8.5
    - hardness - should be < 50 ppm
    - iron - should be < 0.3 ppm
    - copper - should be < 1.3 ppm
    - total chlorine - should be < 4 ppm

## SD 2 - 2 of 2 Testing Water Samples Student Activity Sheet

Record the data for your samples below.

| Sample Name | pH | Hardness | Iron | Copper | Chlorine |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

Compare your results to those testing the same samples as you. Were there any differences? What could explain that?

Record the data for the samples collected by your classmates below.

| Sample Name | pH | Hardness | Iron | Copper | Chlorine |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

**Data Analysis**

In your own words, answer the following questions about **each sample's quality**. Use evidence from your testing to support your answers. Did it meet EPA standards? Is it safe to drink?

**Personal Reflection**

Did any of the results surprise you? Why or why not?