

TESTING THE WATERS

HOW GOOD IS THAT BOTTLED WATER AND HOW EFFECTIVE IS YOUR WATER FILTER?

©2009, 2003, 1997 by David A. Katz. All rights reserved.
Reproduction permitted for education use provided original copyright is included.

Concerned about your drinking water? Don't like the taste of chlorine or other materials in your water? Are there metals such as copper and lead in the water? Chances are, if you have concerns about the water you drink, you may be using bottled water or have purchased or considered purchasing some kind of water filtration system.

The tap water in most communities throughout the U.S. is safe to drink. That water comes from rivers or wells. Most municipalities will clarify the water by sedimentation or filtration and treat the water with chlorine to kill any harmful bacteria. The normal processing does not remove dissolved minerals and salts. Often, a fluoride compound is added to water to reduce tooth decay.

Bottled water is usually spring water from some natural spring. (In some cases, companies have bottled local tap water and sold it as spring water.) Generally, this water has been filtered through the earth and collects in underground reservoirs called *aquifers*. Such waters will contain dissolved minerals that will contribute to its taste. If the water collects in aquifers where there is no decayed organic matter or nutrients, it is usually bacteria free. However, contaminants and bacteria can pass through the ground to contaminate the water.

One of the simplest, and the most common, water filtration systems is the water filtration pitcher. This type of pitcher consists of a upper reservoir with a filter cartridge attached at the bottom. The filter cartridge generally contains an ion exchange resin that removes most of the metallic elements in the water and activated carbon which removes chlorine and other constituents that may affect taste and odor.

In this experiment, you will compare the taste of some different waters and will determine the effectiveness of a water filtration system by testing for dissolved solids, pH, hardness, iron, chlorine, lead and copper.

Dissolved solids are the minerals and salts that are contained in the water. The federal guideline for total dissolved solids and maximum contamination level is 500 mg per liter.

pH is an indication of acidity or alkalinity of the water. Ideally, water should be neutral with a pH of 7. Acidic water will have a pH less than 7 and will have a sour taste as acidity increases. Basic or alkaline water will have a pH above 7 and will have a bitter taste as alkalinity increases. Neutral, or nearly neutral water has a pH of about 7 and should have no sour or bitter taste. The pH will affect the amount of minerals and salts that dissolve in natural water.

Hardness in water is caused by dissolved minerals, primarily calcium (Ca^{2+}), magnesium (Mg^{2+}), iron (Fe^{2+}), strontium (Sr^{2+}), zinc (Zn^{2+}), and manganese (Mn^{2+}) with calcium and magnesium present in significant concentrations. Hard water will affect the action of soaps and will result in the buildup of white deposits and scale around water faucets and sinks.

Iron may be present in water as iron(II), Fe^{2+} , which can oxidize to iron(III), Fe^{3+} . It comes from natural deposits in the environment and from iron pipes in water systems. Iron will result in stains to laundry and porcelain and is more of a nuisance than a health hazard.

Chlorine is the disinfectant most frequently used for water and wastewater treatment. Depending on the source of water in your locality, the amount of chlorine can vary from a slight amount, that is hardly noticeable, to a higher concentration that some people find objectionable. When chlorine is added to water, it forms hydrochloric (HCl) and hypochlorous (HClO) acids. The hypochlorous acid is responsible for the disinfectant action as well as a bleaching action.

Chlorine is also present in water combined with metals in the form of chlorides. When sodium is present in drinking water, chlorides in excess of 250 mg/L will result in a salty taste. The maximum allowable chloride concentration in drinking water is 250 mg/L. Since chlorides are essential in the diet and are not known to be toxic, that amount has been established for reasons of taste rather than for any hazardous reasons.

Lead and its compounds are poisonous and accumulate in the bone structure when ingested. Accumulation of significant amounts of lead in the body may cause severe and permanent brain damage, convulsions, and death. Lead is not commonly found in surface waters as it is normally precipitated by many substances. There has been concern that lead may be leached into drinking water from the tin-lead solder used in joining copper pipes.

Copper concentrations in drinking water are usually very low and is not considered a health hazard. When copper concentrations exceed more than 1 mg/L, it can impart a bitter taste to the water. Large oral doses of copper compounds can cause vomiting and eventually may cause liver damage.

Arsenic and its compounds are poisonous. Arsenic compounds irritate the stomach severely and affect the heart, liver and kidneys. Accumulation of arsenic in the body will result in nervousness, thirst, vomiting, diarrhea, cyanosis, and collapse. Arsenic is most likely found in well water rather than municipal water or bottled water and usually results from mining or metallurgical operations. The maximum amount of arsenic permitted in drinking water is 0.05 mg/L.

Materials Needed

Water for testing – approximately 500 mL are needed to complete all tests

Water to be used may be tap water, purified tap water, well water, or bottled spring water.

For bottled water, 2 bottles of each brand is recommended, one for testing, one for tasting.

paper or plastic cups for water tasting

chemical mix to “spike” water for testing

water test kits for hardness, lead, copper, iron, arsenic, and chlorine

These procedures use Hach water test kits:

Total Hardness and Iron Test Kit, Model HA-77

Lead (LeadTrak), Model DR 100

Copper, Free and Total Test Kit, Model Cu-6

Free and Total Chlorine Test Kit, Model CN66

EZ Arsenic Test Kit 28228-00

pH meter with pH electrode

Buffer solutions, pH 7 and pH 4

Two water filtration pitchers such as Brita® Water Filtration Pitchers. (Three pitchers recommended so that one can be reserved specifically for tasting purposes.)

4 beakers, 100 mL

3 beakers, 250 mL

Plastic beakers, 250-mL (for lead test)

Plastic bottle, 50-mL (for lead test)

hot plate

microscope, 30 power or greater (Note: Radio Shack sells a battery operated microscope that can be used to examine the residue in the 250 mL beaker.)

Spectronic 20 spectrophotometer

Cuvettes

Safety

All glassware and apparatus used for tasting must be clean and free from laboratory chemicals. Use only special glassware and equipment that has been stored away from all sources of laboratory chemical contamination and reserved only for food experiments.

Wash your hands with soap and water before tasting any water.

Safety glasses or goggles must be worn in the laboratory at all times.

This experiment will involve tasting water. All work surfaces where taste materials are located must be clean and free from laboratory chemicals. It is advised to cover the cleaned work area with aluminum foil or a food-grade paper covering. All water for tasting must come from fresh water sources and should be isolated from all areas where laboratory chemicals have been used.

Use new paper or plastic drinking cups for water tasting. Store all cups away from any sources of chemical contamination.

Use only new bottles of bottled water for tasting.

During testing, never return any water to the container from which it was obtained as it will contaminate the entire container of water. Dispose of excess water in the sink or as directed (for lead or other contaminated samples).

Taste water from a water filtration pitcher that has been reserved for tap water only.

Do not taste any water that was chemically treated for laboratory testing purposes, even if it has been filtered to remove contaminants.

Tap water should be obtained from an area where there is no possibility of chemical contamination. The container should be used for drinking water only and should be stored away from any sources of chemical contamination.

Disposal

Generally, the waste materials in this experiment can be disposed in the trash (solids) or poured into the proper waste bottles provided in the laboratory. All disposal must conform to local regulations.

The chemically augmented water contains small amounts of lead and arsenic. That water, and any other samples containing lead, should be disposed of in accordance with local regulations.

Procedure

These experiments are designed to be performed either individually or in teams of 2 persons. Data will be shared between teams. Each team will be assigned a specific type of water to test.

Testing will be conducted on tap water, chemically contaminated (or augmented) tap water, different brands of bottled water, and filtered water.

The laboratory should be set up with each lab bench as a different station for one or two specific water tests. You will move from station to station to perform each of the water tests. Do not move any apparatus or solutions from one table to another.

It is imperative that you rinse all testing tubes, beakers, flasks, and bottles at least twice with distilled or deionized water immediately after completing each test to prevent contamination of samples for additional testing either by you or the next student.

Testing for dissolved solids

Obtain a clean, dry 250 mL beaker. Label the beaker on the labeling area with a pencil with the type of water you will be testing. Weigh the beaker to 0.001 g and record the mass.

Using a graduated cylinder, measure 100 mL of the type of water you are testing into the beaker.

Place a hot plate on the side of the lab bench where it will not be disturbed. Place the beaker of water on the hot plate and allow the water to evaporate.

After all the water has just evaporated, remove the beaker from the hot plate and allow it to cool. Weigh the beaker and record its mass. (Note: If the beaker and residue weighs *less* than the empty beaker, clean out the beaker at the end of this procedure, dry it well, and reweigh it.)

Calculate the mass of the dissolved solids in mg. This is the mass of dissolved solids in 100 mL of water. Multiply by 10 to get the mass of dissolved solids per liter.

Examine the solid residues in the beakers with a 100 power or greater microscope. You may have to use a spatula to scrape some of the residue from the beaker to a microscope slide.

If you are testing more than one type of water, repeat this procedure with another type of water.

Testing pH

This procedure uses either a laboratory pH meter. (Your instructor will demonstrate the use of the laboratory pH meter.)

The pH meter should be set up and calibrated, by your instructor, for this experiment. The pH electrode must remain wet between tests to maintain its calibration. It is normally placed in pH 7 buffer solution. Once the pH meter has been calibrated, do not touch any controls on the pH meter.

Obtain a 100 mL beaker and a 250 mL beaker. If necessary, clean the 100 mL beaker with soap/detergent and water. Rinse the 100 mL beaker three times with distilled or deionized water.

Place approximately 20 mL of the type of water you are testing in the 100 mL beaker.

The pH electrode should be in pH 7 buffer solution. The pH meter display should read very close to 7 (between 6.9 and 7.1) or, the value of the buffer solution if it is different from 7. If it is necessary to adjust the calibration of the pH meter, ask your instructor for assistance.

Remove the pH electrode from the buffer solution. Suspend the pH electrode over the 250 mL beaker. With a wash bottle, rinse the pH meter electrode with distilled or deionized water. Remove any drops of water from the electrode by touching it to a paper towel. (DO NOT WIPE THE ELECTRODE.)

Place the pH electrode into your water sample in the 100 mL beaker. Allow the reading to stabilize. Record the pH value of the water sample.

After the test, rinse the electrode with distilled or deionized water and place it back into the pH 7 buffer solution.

If you are testing more than one type of water, repeat the pH measurement with another type of water. (It is not necessary to repeat the step with the buffer.)

Hardness

This test uses the Hach Total Hardness and Iron Test Kit, HA-77.

Fill the 125-mL flask to the 100 mL mark with the type of water you are testing.

Add two **droppersful** (about 2 mL) of Buffer Solution (labeled *Hardness 1*) to the flask. Swirl to mix.

Add four drops of ManVer[®] Hardness Indicator (labeled *Hardness 2*) to the flask. Swirl to mix. A blue color indicates soft water.

If the solution is pink in color, add Titrant Reagent (labeled *Hardness 3*) **one drop at a time**, holding the dropper vertically above the flask, and swirling after each drop, until the solution color changes from pink to blue. Record the number of drops used to produce the color change. Note: For very hard water you may require over 100 drops.

One drop of Titrant Reagent is equal to 1 mg/L as calcium carbonate, CaCO₃.

Discard the solution. Rinse the flask with distilled or deionized water.

If you are testing more than one type of water, repeat the hardness test with another type of water.

Chemistry of the hardness test

The water sample is treated with hydroxylamine hydrochloride, an organic amine, and buffered to a pH of 10.1. The indicator is calmagite, an organic dye, which reacts with calcium and magnesium ions to give a red colored complex. As the titrant, EDTA (ethylenediaminetetraacetic acid), is added, it reacts with the free calcium and magnesium ions, first, and then removing them from the dye. When the ions are removed from the indicator, the color changes from red to blue.

Iron

This test uses the Hach Hardness and Iron Test Kit, HA-77.

Fill a viewing tube to the 5 mL mark with the type of water you are testing. (The 5 mL mark is the lower mark on the flat-bottom test tube in the kit.)

Tear open one FerroVer Iron Reagent Powder Pillow. Add the contents of the pillow to the sample in the viewing tube. Swirl to mix. If iron is present, an orange color will develop.

Place the tube in the top right opening of the color comparator.

Place some untreated water of the type of water you are testing into a second viewing tube. Place it in the top left opening of the color comparator.

Hold the comparator up to a light source and view through the opening in the front. Rotate the disc to obtain a color match. The iron concentration in mg/L is read through the scale window.

Discard the solutions. Rinse the viewing tubes with distilled or deionized water.

If you are testing more than one type of water, repeat the iron test with another type of water.

Chemistry of the iron test

The FerroVer[®] Iron Reagent reacts with all the soluble and most of the insoluble iron in the sample to produce soluble iron(II) ions. This reacts with 1,10-phenanthroline indicator to produce an orange color in proportion to the iron concentration.

Chlorine

These tests use the Hach Free Chlorine and Total Chlorine Test Kits, CN-66.

Free Chlorine

Fill a viewing tube to the 5 mL mark with the type of water you are testing. Place it in the top left opening of the color comparator. (The 5 mL mark is the lower mark on the flat-bottom test tube in the kit.)

Fill a second viewing tube to the 5 mL mark with the type of water you are testing.

Tear open one DPD Free Chlorine Reagent Powder Pillow. Add the contents of the pillow to the sample in the second viewing tube. Swirl to mix.

Place the tube in the top right opening of the color comparator.

Hold the comparator up to a light source and view through the opening in the front. Rotate the disc to obtain a color match. Within one minute, read the free chlorine concentration in mg/L is read through the scale window.

Discard the solutions. Rinse the viewing tubes with distilled or deionized water.

If you are testing more than one type of water, repeat the free chlorine test with another type of water.

Chemistry of the free chlorine test

Free chlorine is present as hypochlorous acid, HClO, and/or hypochlorite ion, ClO⁻. The chlorine immediately reacts with DPD (N,N-diethyl-p-phenylenediamine) to form a red color that is proportional to the free chlorine concentration.

Total Chlorine

Fill a viewing tube to the 5 mL mark with the type of water you are testing. Place it in the top left opening of the color comparator. (The 5 mL mark is the lower mark on the flat-bottom test tube in the kit.)

Fill a second viewing tube to the 5 mL mark with the type of water you are testing

Tear open one DPD Total Chlorine Reagent Powder Pillow. Add the contents of the pillow to the sample in the second viewing tube. Swirl to mix.

Let the sample stand for 3 minutes. Then place the tube in the top right opening of the color comparator.

Hold the comparator up to a light source and view through the opening in the front. Rotate the disc to obtain a color match. The total chlorine concentration in mg/L is read through the scale window within one minute.

The combined chlorine concentration is obtained by subtracting the free chlorine concentration from the total chlorine concentration.

Discard the solutions. Rinse the viewing tubes with distilled or deionized water.

If you are testing more than one type of water, repeat the total chlorine test with another type of water.

Chemistry of the total chlorine test

In addition to free chlorine, combined chlorine exists as monochloramine, dichloramine, nitrogen trichloride, and other chloro derivatives. The chloride reacts with iodide in the reagent to produce iodine

that combines with DPD (N,N-diethyl-p-phenylenediamine) to form a red color that is proportional to the chlorine concentration.

Lead

This test uses the Hach LeadTrak™ Test system, DR 100 and a Spectronic 20 spectrophotometer. This test involves several steps. To be successful, keep all reagents in numerical order to insure all steps are followed in the correct order.

Measure 100 mL of the type of water you are testing using a graduated cylinder and pour into a clean 250 mL plastic beaker. (Lead free glass beakers can be used)

Add 1.0 mL of pPb-1 Acid Preservative Solution using the graduated plastic dropper provided. Swirl to mix. Wait 2 minutes.

Using the second graduated plastic dropper provided, add 2.0 mL of pPb-2 Fixer solution to the solution in the 250-mL plastic beaker. Swirl to mix.

Obtain a new, wrapped Fast Column Extractor (the plastic tube that looks like a syringe bottom). The Fast Column Extractor contains a specially treated piece of cotton in it – DO NOT REMOVE THE COTTON.

Place the Fast Column Extractor (the plastic tube) on a ring stand with a clamp. Place a 150 mL beaker under the Extractor. Add 20 mL of distilled or deionized water to the extractor to wet the cotton plug. Place the plunger in the Extractor and compress the cotton plug. Remove the plunger from the extractor. If the cotton moves up the Extractor tube, use a glass stirring rod to push it down to the bottom.

Slowly pour the prepared sample solution in the 250 mL beaker into the extractor. After the flow of liquid has stopped, insert a syringe plunger into the extractor and compress the absorbent material to remove any retained water. Slowly remove the plunger from the extractor. The compressed absorbent material inside the extractor should remain against the bottom of the extractor. Discard all the water in the 150 mL beaker. Save the plunger for reuse.

Place the 50 mL plastic bottle, labeled “sample bottle” under the Fast Column Extractor. Measure 25 mL of pPb-3 Eluant into a 25-mL graduated cylinder. Pour the eluant into the column extractor. Allow the liquid to drip into the plastic sample bottle.

Place the syringe plunger into the Extractor and slowly force any remaining eluant through the extractor into the plastic sample bottle. Then remove the Extractor from the clamp. The empty Extractor should be discarded in the trash. Save the plunger for reuse.

Add 1.0 mL of pPb-4 Neutralizer to the sample in plastic sample bottle using the graduated dropper provided. Swirl to mix. Open one pPb-5 Indicator Powder Pillow and add the contents to the sample in plastic sample bottle. Swirl to dissolve. Wait 2 minutes.

Procedure using a Spectronic 20 spectrophotometer

Fill two glass or plastic cuvettes approximately $\frac{3}{4}$ full, or to the fill line, with the prepared sample from the plastic sample bottle. This is a volume of approximately 3 mL.

Add 3 drops of pPb-6 Decolorizer Solution to one of cuvettes. Stopper the cuvette and invert to mix. This is the blank solution.

The Spectronic 20 spectrophotometer should be set to 477 nm. (If you are not sure, ask for assistance.)

Open the light shield (the top) of the Spectronic 20 spectrophotometer. Place the cuvette containing the blank solution into the sample well with the clear side, or the white mark, facing forward. Close the light shield. Press the 0 Abs/100% T button. The meter should read 0.

Remove the blank solution. Place the second cuvette containing the sample into the sample well with the clear side, or the white mark, facing forward. Close the light shield. Read and record the absorbance of the lead solution.

The concentration of lead in $\mu\text{g/L}$ is determined from the corresponding values on the calibration graph.

Discard solutions as directed. Rinse all apparatus with distilled or deionized water.

If you are testing more than one type of water, repeat the lead test with another type of water

Chemistry of the lead test

Acid soluble lead is concentrated on a Fast Column Extractor. The lead is then eluted from the Extractor with dilute nitric acid, neutralized with a basic solution of sodium hydroxide, and reacted with a meso-tetra-(4-N-Methylpyridyl) Porphine Tetratosylate indicator. The concentration of lead is determined colorimetrically.

Copper

This test uses the Hach Total Copper Test Kit, CU-6.

Rinse both color viewing tubes three times with 5 mL portions of the type of water you are testing. Then fill both tubes to the 5 mL line with the type of water you are testing. (The 5 mL mark is the lower mark on the flat-bottom test tube in the kit.)

Place the one tube of water into the left top opening of the color comparator.

Open one Free Copper Reagent Powder Pillow and add the contents to the second tube. Stopper the tube and invert several times to mix. If free copper is present, a purple color will develop. Allow the sample to sit for 2 minutes. Place this treated tube in the right top opening of the color comparator.

Hold the comparator up to a light source and view through the opening in the front. Rotate the disc to obtain a color match. The free copper concentration in mg/L is read through the scale window.

Remove the tube of treated water from the right top opening of the color comparator. Add the contents of one Hydrosulfite Reagent Powder Pillow to the tube. Stopper and invert several times to mix. Allow the tube to stand for two minutes.

Replace the tube in the color comparator. Hold the comparator up to a light source and view through the opening in the front. Rotate the disc to obtain a color match. The total copper concentration in mg/L is read through the scale window.

The complexed copper concentration is obtained by subtracting the free copper concentration from the total copper concentration.

Discard the solutions. Rinse the viewing tubes with distilled or deionized water.

If you are testing more than one type of water, repeat the copper tests using another type of water.

Chemistry of the copper test

The copper in the water reacts with a salt of bichinonic acid to form a purple colored complex in proportion to the copper concentration. The sodium hydrosulfite reagent will reduce dissolved copper to free copper.

Arsenic

This uses the Hach EZ Arsenic Test Kit 28228-00 for the 0-500 ppb Range

Remove the black cap from the test bottle. Lift the flap on the black cap and slide a test strip into the groove so that the reactive pad faces the small opening and completely covers it. Press the flap back in place to secure the test strip.

Add the water you are testing to the reaction bottle to the top edge of the line. This is a volume of about 50 mL.

Add the arsenic reagents to the water in the bottle. One Reagent #1 and one Reagent #2. Place the black cap, with the test strip in place, on the bottle. Swirl gently to dissolve. DO NOT SHAKE. Do not allow the water to come in contact with the test strip.

Allow the materials in the bottle to react for 20 minutes. Swirl twice during the reaction period.

Remove the test strip and immediately compare the developed color on the reactive pad to the 50 mL row, 0-500 ppb, chart on the test strip bottle.

Discard the solutions. Rinse the test bottle with distilled or deionized water.

If you are testing more than one type of water, repeat the arsenic test using another type of water.

Chemistry of the arsenic test

Any hydrogen sulfide present in the water sample is oxidized to sulfate to prevent interference and the oxidizing environment is then neutralized. Sulfamic acid and powdered zinc, in the reagents, to reduce any inorganic arsenic to arsine gas (AsH_3). The arsine gas reacts with mercury(II) bromide in the test strip to form mixed arsenic/mercury halogenides that discolor the test strip. The colors range from yellow through tan to brown, depending on the arsenic concentration

Tasting water

All water should be at the same temperature.

Obtain sufficient paper or plastic cups for the types of water being tasted. Mark the cups accordingly for identification of the water samples.

Place a sample of the tap water for tasting in cup 1.

Place a sample of filtered tap water in cup 2. CAUTION: Do not taste filtered chemically contaminated water.

Place a sample of bottled water in cup 3.

If you are tasting more than one brand of bottled water, place samples in appropriately labeled cups.

Taste small quantities of each water in sets of two. (That is compare the tastes of cups 1 and 2. Then compare cups 1 and 3. etc...)

How do you characterize each type of water?

Conclusion and Clean-up

At the conclusion of the experiment, write your results on the chalk board or whiteboard
Any container used for tasting water should be stored in a protected area, away from any possible contamination by foreign materials or laboratory chemicals.

Bottled water used for testing should be discarded and the container disposed of or recycled.

Bottled water used only for tasting can be removed from the laboratory for later consumption.

All testing containers should be rinsed with distilled or deionized water before storage.

TESTING THE WATERS

HOW GOOD IS THAT BOTTLED WATER AND HOW EFFECTIVE IS YOUR WATER FILTER

DATA and RESULTS

Name (s) _____

Date _____

Water Information:

Complete the information below for the type of water you tested in this experiment.

Locality where tests are being performed: _____

What is the source of the water? _____
(Note: You may have to contact the water company to find the water source.)

Brand(s) of bottled water used: _____

Brand of water filtration pitcher used: _____

NOTE: All water data will be shared with the class. In addition to writing your results on these data pages, you will also write your data on the chalk board/white board in the laboratory. A summary chart appears on page 15 of this experiment.

Dissolved solids: (Add your data to this table for the type(s) of water you tested. Also, add your data to the summary table on the chalk board/white board in the laboratory and the summary chart on page 15.)

Type(s) of water used	Mass of empty beaker, g	Mass of beaker and residue, g	Mass of dissolved solids, g	Dissolved solids in mg/L

Results of the microscopic examination of the dissolved solids. What did you observe?

Federal guidelines for *total dissolved solids* and *maximum contaminant level* in tap water is 500 mg/L. How do the samples compare?

pH

Record the pH of each type of water using your data and class data: (Add your data to this table for the type(s) of water you tested. Also, add your data to the summary table on the chalk board/white board in the laboratory and the summary chart on page 15.)

Type(s) of water			
pH			

Hardness

Record the total hardness of each type of water in mg/L as calcium carbonate. (Add your data to this table for the type(s) of water you tested. Also, add your data to the summary table on the chalk board/white board in the laboratory and the summary chart on page 15.)

Type(s) of water			
Total hardness as CaCO ₃			

Iron

Record the iron concentration in mg/L for each type of water: (Add your data to this table for the type(s) of water you tested. Also, add your data to the summary table on the chalk board/white board in the laboratory and the summary chart on page 15.)

Type(s) of water			
Iron concentration In mg/L			

Chlorine

Record the concentration of total and free chlorine for each type of water in mg/L and calculate the concentration of combined chlorine. (Add your data to this table for the type(s) of water you tested. Also, add your data to the summary table on the chalk board/white board in the laboratory and the summary chart on page 15.)

Type(s) of water			
Free chlorine in mg/L			
Total chlorine in mg/L			
Combined chlorine in mg/L			

Lead

Record the lead concentration in $\mu\text{g/L}$ for each type of water. (Add your data to this table for the type(s) of water you tested. Also, add your data to the summary table on the chalk board/white board in the laboratory and the summary chart on page 15.)

Type(s) of water			
Lead concentration in $\mu\text{g/L}$			

Copper

Record the concentration of total and free copper for each type of water in mg/L and calculate the concentration of combined copper. (Add your data to this table for the type(s) of water you tested. Also, add your data to the summary table on the chalk board/white board in the laboratory and the summary chart on page 15.)

Type(s) of water			
Free copper in mg/L			
Total copper in mg/L			
Combined copper in mg/L			

Arsenic

Record the arsenic concentration in ppb for each type of water. (Add your data to this table for the type(s) of water you tested. Also, add your data to the summary table on the chalk board/white board in the laboratory and the summary chart on page 15.)

Type(s) of water			
Arsenic concentration in ppb			

Water Tasting

Describe the taste of the tap water:

Describe the taste of the filtered tap water:

Describe the taste of the bottled water(s):

Which water do you prefer in order of preference? Why?

Questions:

1. When tasting water, why must the different waters be at the same temperature?
2. Does the water filter pitcher remove the contaminants as it claims? Explain.
3. Is the bottled water as pure as you thought it was before doing this experiment? Explain.
4. What is the difference between purified water, spring water, and natural spring water?
5. If the value of any measurement for the water tested was very high, what would you do?
6. Calculate the cost of tap water for one year. (Calculate the amount of water, in quarts, you would drink in one day, multiply by 365 days, multiply by the cost of a quart of tap water. (You will have to call the local water company to get the cost of the water.)

7. Calculate the cost of using a water filter pitcher for one year. The pitcher, with one filter, costs an average of \$20.00. A filter will process about 140 quarts of water. A replacement filter costs \$7.00 (Calculate the amount of water, in quarts, you would drink in one day and multiply by 365 days. Divide by 140, subtract 1, and multiply by \$7.00/filter. Add \$20.00 for the cost of the pitcher and original filter.)
8. Assuming a one-Liter bottle of water costs \$1.00. How much would you spend on bottled water over the course of one year? (Calculate the amount of water, in Liters, you would drink in one day and multiply by 365 days and by \$1.00/Liter)
9. Taking into account the taste, the purity of the water and the cost for one year, which is your choice of water? Explain.