



DIY

What Are Acids & Bases?

The mission of the U.S. Department of Energy Office of Legacy Management (LM) is to ensure the protection of human health and the environment at sites that once played a role in the Manhattan Project and the Cold War. At these sites, LM scientists conduct many studies, including measuring potential hydrogen (pH) in groundwater to determine its acidity.

Acids and bases are all around us. An **acid** is something that tastes sour (like a lemon) and tends to dissolve things. A **base** is something that feels slippery (like soap) and will neutralize an acid. Low-pH acids and high-pH bases can cause chemical burns and should be handled with extreme caution.



Groundwater monitoring at St. Charles County, Missouri. ▶

- Duration:** 30 minutes
- Key Definitions:** acid, base, pH, litmus paper, electrochemical meter
- Objective:** To learn the difference between an acid and a base and how to test for each using litmus paper
- NGSS Standard:** MS-ESS3-3 Earth and Human Activity; apply scientific principles to design a method for monitoring and minimizing human impacts on the environment (grades 6-8)

pH Scale



The pH scale

When scientists monitor groundwater for acidity, they use something called the **pH** scale. The pH scale goes from zero (the most acidic) to 14 (the most basic). Seven, the number in the middle, is considered neutral. This is the pH of distilled water. A high pH number (strong base) or a low pH number (strong acid) can be harmful to our health and the environment.

In this activity, you will test pH levels, using litmus paper test strips. If you do not already have a packet of litmus paper test strips, you can easily find some online.

Let's be a scientist!

Litmus paper measures pH. It is made from dyes extracted from different types of lichen. Lichen is algae and cyanobacteria (also known as moss) that grow on trees and rocks all around the world. If the litmus paper turns red, it is acidic. If it turns blue, it is basic. The more intense the red or blue color, the stronger the acid or base. Let's test the pH of items around your house.



Remember that some chemicals around your house are strong **acids** or **bases** and can be dangerous. Always wear eye protection and gloves when using them!



Materials

- Goggles and latex gloves for safety.
- Litmus paper test strips.
- Small cup or bowl.
- Teaspoon.
- Spoon.
- Paper towel.
- Baking soda.
- Lemon juice.
- Vinegar.
- Liquid laundry detergent.
- Markers or colored pencils.
- Optional: clear liquids, such as lemon-lime soda, shampoo, bleach, etc.

Now it is time to put on your safety glasses and gloves.

Let's start by testing baking soda.

1. Pour a small amount of water into your cup or bowl.
2. Measure a teaspoon of baking soda.
3. Pour the baking soda from the teaspoon into your cup or bowl.
4. Grab the regular spoon and stir your cup or bowl until the baking soda dissolves completely.
5. Open your packet of litmus paper test strips and tear off one of the strips.
6. Hold one end of the test strip and dip the other end into the cup or bowl.
7. Hold the test strip in the liquid for about two seconds and then remove it.
8. Place the test strip on your paper towel.

Look again at the packet of litmus paper test strips. You will notice that inside there is a scale from 1 to 14, with a color next to each number. Hold the packet close to the test strip you just dipped and see what color it most closely resembles.



Baking soda

Color in the scale below, using the color that appeared on your test strip.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

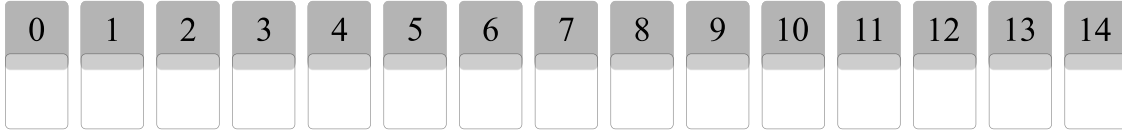
Is baking soda an acid or a base? _____

Take the cup or bowl with the baking soda and water mixture and pour it into the trash. Wipe the bowl or cup with a paper towel and dispose of the paper towel in the trash.

Lemon juice

Next, let's try lemon juice. Since it is already liquid, you don't need to dissolve it. Just pour a small amount of lemon juice (about a tablespoon) into the cup or bowl. Tear off another test strip and dip it into the lemon juice. Lay the test strip on the paper towel.

Color in the scale below, using the color that appeared on your test strip.

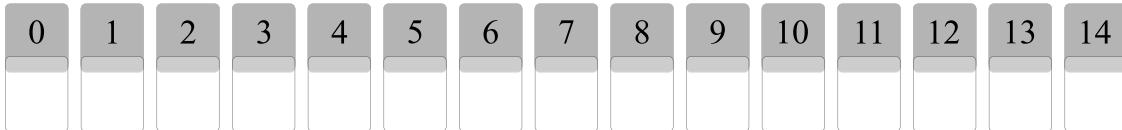


Is lemon juice an acid or a base? _____

Clean the bowl or cup again and repeat the experiment with the other materials you collected. If it is a powder, then repeat the steps for baking soda. If it is a liquid, repeat the steps you used for lemon juice.

Vinegar

Color in the scale below, using the color that appeared on your test strip.



Is vinegar an acid or a base? _____

Liquid laundry detergent

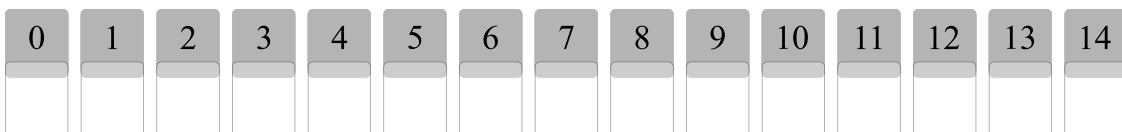
Color in the scale below, using the color that appeared on your test strip.



Is liquid laundry detergent an acid or a base? _____

Finally, let's test your water!

Pour a small amount of water into the cup or bowl. Color in the scale below, using the color that appeared on your test strip.

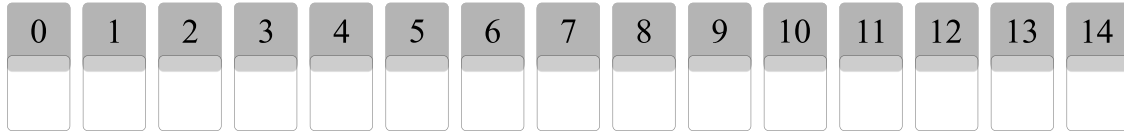


Is your water an acid or a base? _____

Having fun? Want to keep experimenting?

1. What did you test? _____

Color in the scale below, using the color that appeared on your test strip.



Was it an acid or a base? _____

2. What did you test? _____

Color in the scale below, using the color that appeared on your test strip.



Was it an acid or a base? _____

Thinking like a scientist!

You conducted an experiment just like a scientist! Now we need to examine what we have learned.

What was the highest pH number you recorded? _____

What was the lowest? _____

Why do you think some liquids have a high pH and others have a low pH? _____

Scientists also research information when they have questions. Now, do your own research at a library or on the internet and discover why some liquids have a high pH and why some have a low pH. Finally, be a scientist and share what you have discovered with a friend or family member.

While it is fun to use litmus paper, scientists use **electrochemical meters** to test pH levels because they provide more accurate results. Electrochemical meters use an electrical current that passes through the liquid to test its pH level. LM scientists regularly test water quality to help ensure protection of human health and the environment.

ANSWER KEY

Baking soda: slightly blue, around 8, base. **Lemon Juice:** red, around 2, acid. **Vinegar:** red, around 3, acid.

Laundry detergent: blue, around 10, base. **Water:** yellow or green color, pH around 7, neutral.