



Acids & Bases Around the House

Use a pH indicator to find acids and bases

Lesson Plan

Description: Visitors predict whether various household solutions are acids or bases, and test their hypotheses using a universal pH indicator. Then, visitors are challenged to line up household chemicals in “rainbow” (pH) order.

Audience: Hands-on activity for families and children ages 8 and up

Length: 20 minutes

Learning Objectives

Visitors learn:

- Chemicals (including common household products) can be acids, bases, or neutral.
- Acids and bases have characteristic properties.
- When acids and bases combine they neutralize each other, which cancels out their acid and base properties.
- Scientists can use *pH indicators* to identify chemicals as acidic, basic, or neutral.
- Scientists measure the relative strength of acids and bases using the *pH scale*.

Visitors develop skills related to chemistry and science, including:

- Developing and testing predictions
- Observing, communicating, and discussing experimental results

Learning Standards

National Science Education Standards

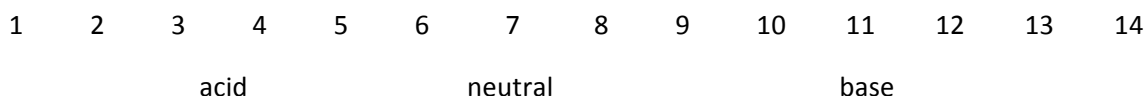
1. Science as Inquiry
 - K-4: Abilities necessary to do scientific inquiry
 - K-4: Understanding about scientific inquiry
 - 5-8: Abilities necessary to do scientific inquiry
 - 5-8: Understanding about scientific inquiry
 - 9-12: Abilities necessary to do scientific inquiry
 - 9-12: Understanding about scientific inquiry
2. Physical Science
 - K-4: Properties of objects and materials
 - 5-8: Properties and changes of properties in matter
 - 9-12: Chemical reactions

Background Information

When most people hear the word “**acid**,” they think of something very dangerous that can dissolve metal and burn skin. In fact, many acids are not dangerous at all. Some are even found in the foods we eat! Any food that tastes sour is acidic. For example, vinegar in salad dressing is acetic acid, oranges and lemons contain citric acid, and apples contain malic acid. Vitamin C is an acid, ascorbic acid.

Bases are also found in common household products. Bases can be very strong and dangerous, or weak and safer for use around the house. Lye or washing soda are very strong bases. Weaker bases are often used as cleaning products, like household ammonia used to clean windows. We don’t find many bases in our foods because they taste bitter—think about the taste of soap!

Chemists use a scale known as the **pH scale** to indicate the amount of acid or base present in a solution. The pH scale goes from 1-14. Neutral substances have a pH of 7. A pH less than 7 is an acid, with lower numbers indicating stronger acids. A pH greater than 7 is a base, with higher numbers indicating stronger bases.



A universal indicator (such as Bogen’s universal indicator) identifies pH by turning a rainbow of colors:

- **Red** (acids of pH ~2-4)
- **Orange** (acids of pH ~5)
- **Green** (pH ~6-7)
- **Blue** (pH ~9)
- **Purple** (pH ~10 and up)

If an acid and base are mixed in equal amounts they react together to make a salt and water.



ACID + BASE → SALT + WATER

In the first part of this activity, visitors use the universal indicator to test what color it turns in acid and what color it turns in base. Then, visitors try to predict whether common household chemicals are acidic, basic, or neutral. They test their predictions using the indicator. Finally, visitors can mix acids and bases to try and get each pH level (indicated by a different color).

EXPECTED RESULTS

| | Vinegar | Lemon juice | Seltzer | Baking soda | Detergent | Ammonia cleaner | Washing soda |
|---------------------|----------|-------------|---------|-------------|-----------|-----------------|--------------|
| Universal indicator | hot pink | pink | orange | green | purple | purple | purple |

Materials**For each pair of visitors**

- Well plate
- Transfer pipettes (around a dozen)
- Labeled dropping bottle of known chemicals:
 - Acid: vinegar (5% acetic acid, by weight)
 - Base: washing soda in water (1% by weight, in water)
 - Water
- Labeled dropping bottle of universal indicator
- Labeled dropping bottles of acids found around the house
 - Seltzer water
 - Lemon juice
 - Vinegar
 - Light-colored sports drink (like Gatorade)
- Labeled dropping bottles of bases found around the house
 - Baking soda (1% solution by weight, in water)
 - Dishwashing detergent (1% solution by weight, in water)
 - Ammonia based cleaner
- Safety glasses and gloves (for each visitor)

For the presenter

- One set of visitors' supplies
- Trash can
- Paper towels (to clean up spills)

Sources

- Bogen's universal indicator, well plates, and pipettes are available from scientific suppliers, including Carolina (<http://www.carolina.com>).
- Safety supplies (glasses and gloves) are available from Flinn Scientific or other scientific suppliers.
- Household chemicals can be found at grocery stores and pharmacies.

Notes to the Presenter

You can let visitors investigate the pH of almost any clear, light-colored liquid that it's safe for them to handle. Visitors like to see the original containers, but it's not convenient for them to work from them. Labeled dropping bottles are easy for visitors to use and minimize spills.

CAUTION: Always supervise visitors during this activity. Be sure visitors wear safety glasses and gloves, and don't let them taste any chemicals (even food or drinks).

Set Up

Set up takes approximately 30 minutes.

(Set up will take longer the very first time you do the activity.)

1. Prepare the known base solution by dissolving 1 gram of washing soda in 100 ml water.
2. Pour the vinegar and water into labeled dropper bottles.
3. Pour the household items into dropper bottles.



Program Delivery

In today's program, we're going to learn about one way that chemists classify foods and other products we can find around the house: as acids or bases.

Do you know what acids and bases are? Can you name any examples? *Range of responses.*

Lots of people think of acids as being super strong chemicals that can burn through your skin. But there are lots of weak acids, too. You even eat some acids! Acids taste sour. *Name or reiterate acids in foods: citric acid in lemons, acetic acid in vinegar, malic acid in apples.*

What about bases? Bases are the opposite of acids. We don't eat bases, because they taste soapy or bitter. Bases can be strong or weak, too—they come in a range of pHs.

Can anyone name any common bases? *Name or reiterate bases found around the house: baking soda, washing soda, ammonia, lye soap.*

Acids and bases can be strong, or weak, or somewhere in between. Chemists measure the strength of acids and bases using a scale called the pH scale.

The pH scale goes from a strong acid at one end (1) to a strong base at the other end (14). In the middle are weaker acids, things that are neutral (meaning they're not acids or bases), and weaker bases. On a pH scale, acids range from 1 to 6, 7 is neutral, and bases range from 8-14. Pure water is neutral and has a pH of 7.

Let's say we had a chemical, like the stuff in this bottle. *Hold up bottle of water.*

How would you figure out what pH this is? Would you want to taste it to see if it's bitter or sour? No! It might be poison.

Here's what you could do: You could use something called an *indicator*. An indicator is a chemical that turns different colors if it's in an acid or a base. Today, we're going to use a *universal indicator*, which indicates the whole range of pH from acid to neutral to base.

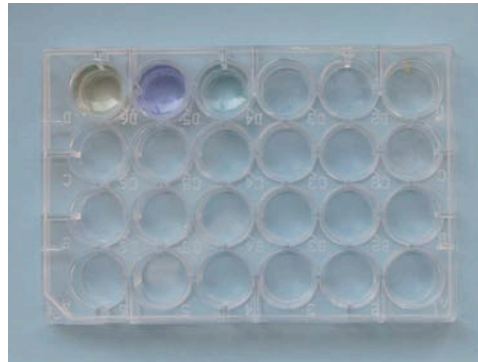
Let's find out how the indicator can help us identify chemicals as acids or bases. We'll test it using a known acid and a known base. Then, we'll try to figure out whether some other chemicals are acids or bases.

Is everyone wearing safety glasses and gloves? *Make sure everyone is wearing safety glasses and gloves.*

Let's get started! *Demonstrate the following procedure.*

Identifying acids and bases with universal indicator

1. Put a few drops of the solution in the "acid" bottle in the first well of the first row. This will be your Acid row.
2. Add a few drops of indicator.
3. Note the color change.
4. Put a few drops of the solution in the "base" bottle in the first well of the second row. That will be your Base row.
5. Add a few drops of indicator.
6. Note the color change.
7. Put a few drops of water in the first well of the third row. This will be your Neutral row.



What color did the indicator turn in acid? *Magenta*

What color did it turn in the base? *Purple*

What about in water, which is pretty close to neutral? *No change/minimal change*

Here's something neat: our indicator doesn't just tell us whether we have an acid or a base—it can tell us how strong it is, too.

I mentioned that we're using a *universal indicator*, which turns different colors depending on the pH. The most acidic is red, then orange, then yellow then green at neutral; then blue and purple.

Now that we know that we know how to use the indicator, we can test some common household products to see if they're acidic, neutral, or basic. *Indicate chemical containers.*

You can predict whether these chemicals are acids, bases, or neutral. You can also predict which ones are stronger. *Demonstrate the following procedure.*

Further exploration

1. Put a few drops of a solution you think is acidic in the Acid row.
2. Add a few drops universal indicator.
3. Note the color change. Was your prediction correct?
4. Now, do the same for products you think are basic and neutral, using the Base and Neutral rows of your well plate. Did you predict correctly?
5. When you're done with that, you can predict which products you think are *more* acidic or basic than others.

And after you get the hang of it, you can experiment by mixing the acids and bases. See if you can get a solution of each color of the rainbow, and try to line them up in rainbow order!

If visitors use up all their wells and want to keep working, they can get a fresh plate or rinse off their plate in the sink.

Clean Up

- The unused universal indicator can be poured into a storage bottle and saved to use again.
- The dropper bottles of acids and bases can be stored to use again.
- Consult the labels of the household chemicals for storage and disposal information.
- Rinse the well plates and leave them out to dry before storing them.
- Paper towels that have been used to clean up spills can be disposed of in the trash.

Credits

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