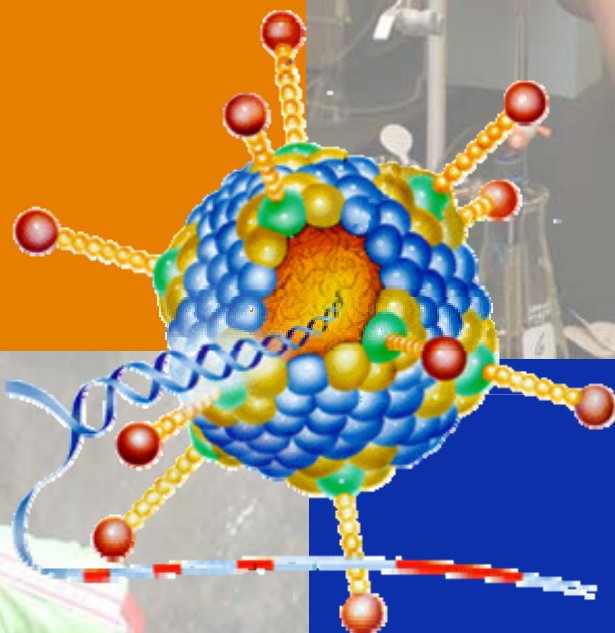


Creating the pH Scale

Lab Book



The waterCAMPWS
Center for Advanced Materials
for Purification of Water with Systems



Overview

A water molecule is made up of two hydrogen atoms and one oxygen atom. Hydrogen atoms are smaller than the oxygen and have a positive charge while the oxygen atom is bigger and has a negative charge. Because of the shape of the molecule, water has a positive end and a negative end, causing the molecule to act like a magnet. Another quality of water is called dissociation. This property of water is responsible for the formation of acids and bases. In water dissociation, a hydrogen atom breaks away from the oxygen atom. In pure water there are an equal number of H^+ ions and OH^- ions. The amount or number of H^+ ions to OH^- ions determines the pH of a substance or whether the substance is acidic, basic or neutral.

Our world would be very different if we did not have acids and bases. Most of the food we eat is acid and our stomach produces very strong acids. The acids help us digest our food. One of the few foods that we eat that is basic is beans and we all know the results of that! Our blood has a pH of about 7.3 which helps our red blood cells to carry oxygen throughout our body! If the pH of water is too high or basic, minerals can settle out of the water causing our water pipes to clog and give us low water pressure. If the pH of our water is too low, or acidic, plumbing fixtures and our hot water heaters can be damaged.

You will use the materials in this lab to create your own pH scale.

Materials and Equipment

Materials required for this lesson are (for each group of students):

- Coffee filters painted with cabbage juice, dried and cut into test strips
- Large pH scale (print on legal paper)
- pH probe & display
- wide range pH paper
- Lemon juice
- Vinegar
- Sprite
- Mr. Pibb
- Pure water
- Baking soda solution
- Household ammonia or oven cleaner
- Quinine water
- Q-tips
- Cups
- Tape

Procedure for pH Scale without the use of Probes

1. Before beginning the experiment, develop a hypothesis about the pH of various substances, based on their properties and characteristics. Write your hypothesis below:

The Good, the Bad, the Silly...

Writing a good hypothesis is harder than you think. For example:

When it gets cold, water turns to ice.

is an acceptable hypothesis, but not very helpful, since there are many temperature ranges of "cold" when ice wouldn't form.

A better hypothesis would be:

When the temperature reaches 32 degrees Fahrenheit and remains at that temperature, water turns to ice.

The hypothesis:

When the temperature reaches 32 degrees Fahrenheit and remains at that temperature in a room with three windows that face North on a Sunday, water turns to ice.

While this last statement may be true, it contains a lot of unnecessary detail that makes it of little practical value, since there are lots of conditions that will cause ice to form that are

Part One:

2. Using the Q tips as a paint brush, paint the lemon juice on a test strip and tape the strip in the box beneath the 2 on the pH chart in the results section.
3. Notice the color change.
4. Take a new Q tip, choose a different substance, and paint in on a test strip.
5. Find its pH and tape it in the appropriate box. You should see colors emerge showing you a pH "range of color".

Part Two

6. Test the unknown substance with the coffee filter strips.
7. Predict the pH of this unknown by comparing the strip with the color spectrum on your pH scale paper.
8. Write this value in the pH column of the table in the results section.
9. Use the pH probe to determine the exact pH of the unknown substance.
10. Write this value next to the predicted value in the table.
11. Tape the test strip in the box to the right.

Results for pH Scale without the use of Probes

Substance Tested pH

Substance Tested	pH
Lemon Juice	2
Vinegar	3
Sprite	4
Mr. Pibb	5
Pure water	7
Baking Soda solution	8
Household Ammonia	11
Unknown	

Analysis for pH Scale without the use of Probes

1. Did you predict the unknown substance to be an acid or a base? Why?

2. What is the color range for an acid according to your cabbage juice scale?

3. What is the color range for a base according to your cabbage juice scale?

4. What are the advantages of testing pH with an indicator?

Substance	pH	Substance	pH
Coke	2.60	nailpolish remover	6.50
Cranapple juice	2.90	Ramen broth	6.59
Dr. Pepper	3.62	root beer	6.63
Hi-C	3.70	soybean milk	6.66
strawberry cooler	4.05	skim milk	6.77
orange slice	4.17	tea	6.79
imit. Mountain Dew	4.20	Pantene Shampoo	6.95
Hi-C and Sprite	4.24	plant food	6.99
Surge	4.25	chocolate milk	7.03
7-Up	4.28	rubbing alcohol	7.17
orange Slice	4.29	Pantene shampoo	7.22
7-up	4.44	Dawn	7.44
citrus Zephyr soda	4.59	ovaltine and milk	7.53
citrus Zephyr soda	4.59	Plax	7.55
Sunny Delight	4.71	409 glass cleaner	7.61
Mr. Pibb	4.90	astringent	7.66
pickle juice	4.98	Ajax liquid	7.80
hotsauce/aftershave	5.19	green tea	7.90
mouth wash	5.33	retainer cleaner	8.04
Listerine	5.45	Denton tap water	8.22
pickle juice	5.55	astringent	9.47
shampoo	5.62	detergent in water	9.68
ibuprofen in water	5.72	kitchen cleaner	10.90
root beer	5.79	Liquid Plumr	12.01
Pepto Bismol	5.81		
Scope	6.34		

5. What word describes the property of water that is responsible for the formation of acids & bases?

6. What ion or part of a water molecule is associated with an acid? Draw a diagram highlighting this part of the molecule.

7. What ion or part of a water molecule is associated with a base? Draw a diagram highlighting this part of the molecule.

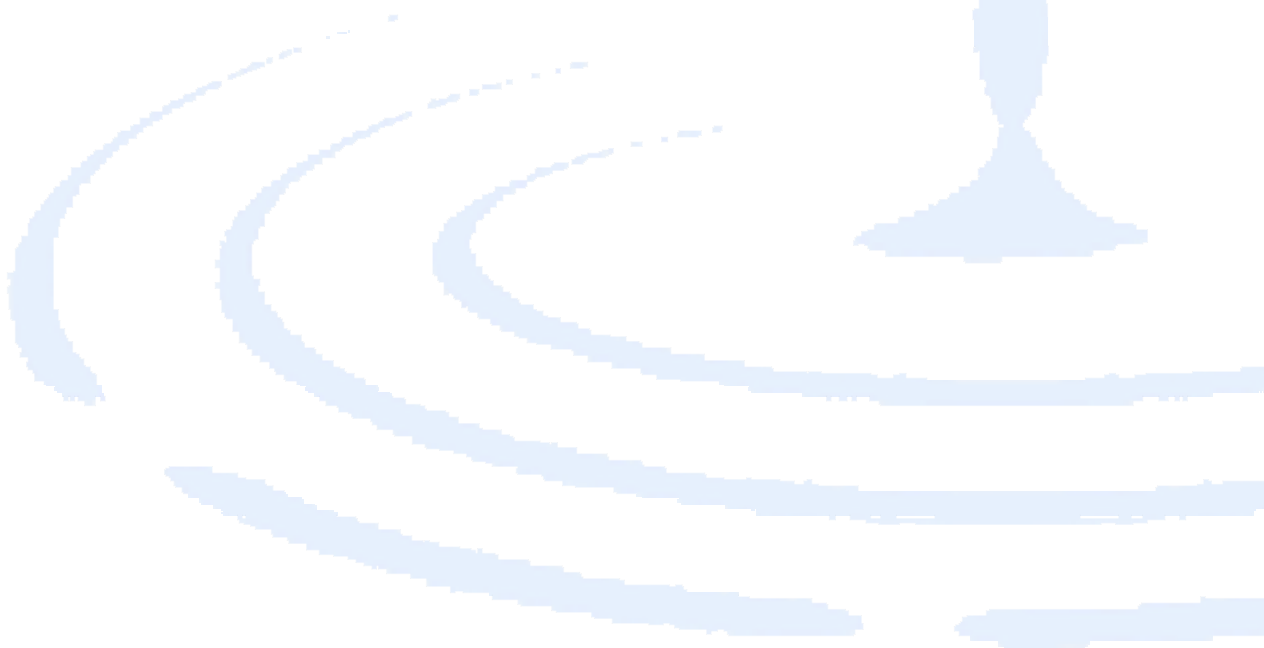
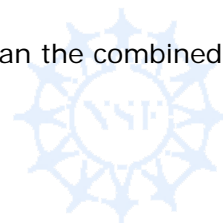
8. What other types of substances would you like to test? Why?



9. In an episode of *The Simpsons*, Marge gives herself amnesia from the fumes that result when she combined all her cleaning products. Based on this experiment, write a script of a conversation between Marge and Lisa where Lisa explains what Marge did wrong and why it was so dangerous.

Extra Credit:

When acids and bases are mixed, the amount of liquid is often more than the combined amounts of the acid and the base. Why might that be?



Procedure using pH Probes and Creating a Color Scale

1. Before beginning the experiment, develop a hypothesis about the pH of various substances, based on their properties and characteristics. Write your hypothesis below:

The Good, the Bad, the Silly...

Writing a good hypothesis is harder than you think. For example:

When it gets cold, water turns to ice.

is an acceptable hypothesis, but not very helpful, since there are many temperature ranges of "cold" when ice wouldn't form.

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The hypothesis:

When the temperature reaches 32 degrees Fahrenheit and remains at that temperature in a room with three windows that face North on a Sunday, water turns to ice.

While this last statement may be true, it contains a lot of unnecessary detail that makes it of little practical value, since there are lots of conditions that will cause ice to form that are excluded in this hypothesis.

2. Test each sample provided with the pH probe.
3. Write their pH on the table in the Results section below.
4. According to the pH indicated on the table above, place a small drop of each liquid on the cabbage juice under the matching number on the pH scale paper.
5. Label each dot according to the material used: vinegar, sprite, etc., in the space provided below the scale.
6. Test the unknown substance using the wide range pH paper or pre-prepared cabbage juice paper.
7. Predict the pH of the unknown substance. Explain your answer.

8. Test the unknown substance with the pH probe and write your results in the table above.

Results for Using pH Probes and Creating a Color Scale

Substance Tested	pH
Lemon juice	
Vinegar	
Sprite	
Mr. Pibb	
Pure Water	
Baking Soda Solution	
Household Ammonia	
Unknown Substance	

Analysis for Using pH Probes and Creating a Color Scale

1. Did you predict the unknown substance to be an acid or a base? Why?

2. What is the color range for an acid according to your cabbage juice scale?

3. What is the color range for a base according to your cabbage juice scale?

4. What are the advantages of testing pH with a pH probe as compared to an indicator?

5. What word describes the property of water that is responsible for the formation of acids & bases?

6. What ion or part of a water molecule is associated with an acid? Draw a diagram highlighting this part of the molecule.

Pepto Bismol	5.81		
Substance	pH	Substance	pH
Scope	6.34		
Coke	2.60	nailpolish remover	6.50
Cranapple juice	2.90	Ramen broth	6.59
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ibuprofen in water	5.72	kitchen cleaner	10.90
root beer	5.79	Liquid Plumr	12.01

7. What ion or part of a water molecule is associated with a base? Draw a diagram highlighting this part of the molecule.

8. What other types of substances would you like to test? Why?

10. In an episode of The Simpsons, Marge gives herself amnesia from the fumes that result when she combined all her cleaning products. Based on this experiment, write a script of a conversation between Marge and Lisa where Lisa explains what Marge did wrong and why it was so dangerous.

Extra Credit:

When acids and bases are mixed, the amount of liquid is often more than the combined amounts of the acid and the base. Why might that be?