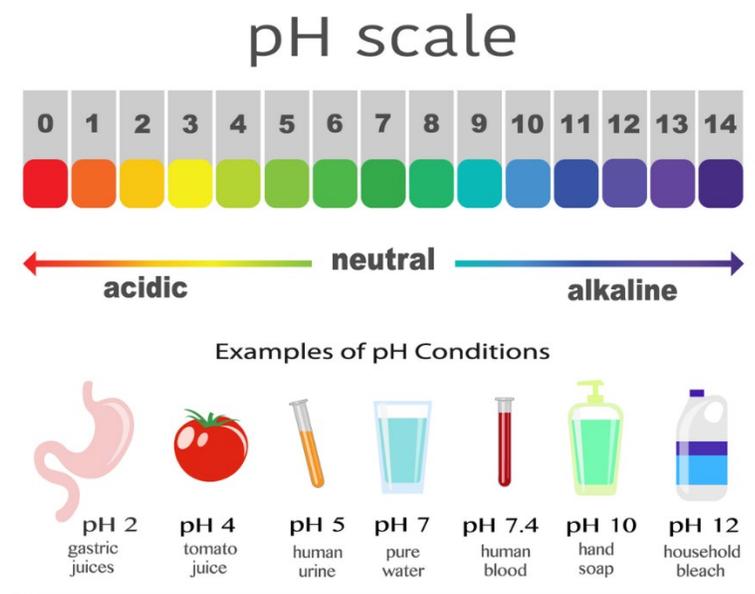


# BLUEBERRY AND CABBAGE MAGIC FAST FACTS

- Water is the “universal solvent,” which means that most things break down in water to form a solution.
- Solutions are liquid mixtures that are not chemically combined.
  - The largest amount of the mixture is the solvent, which is usually water.
  - The smaller amount of the mixture is the solute.
  - An example is Sweet Tea, which is a solution of hot water, sugar, and tea. The water is the solvent. The sugar and tea are the solutes.
  - Solutions can be described in ratios of solvent to solute. For instance, when you cook rice, that solution is 2:1. This means that for every 2 parts of water, you use one part of rice. If you need to cook more rice for more people, for every 8 cups of water, you would use 4 cups of rice, which still works out to a 2:1.
- The chemical formula of water is  $H_2O$ , which means that each water molecule has two hydrogen atoms and one oxygen.
- Hydrogen is unique because when it bonds, it forms a positively charged ion  $H^+$  or bonds with oxygen to form a negatively charged polyatomic ion  $OH^-$ .
- When we measure the pH of a solution, we are measuring hydrogen ion concentrations in a solution.



- $H^+$  ions form acids.
- $OH^-$  ions form bases.
- Acids are sour and corrode metals.
- Bases are bitter and slippery to touch.
- Water’s formula of  $H_2O$  actually works out to be  $H^+$  and  $OH^-$ , which means that pure water is neutral, which is neither an acid nor a base.
- pH is measured on scale of 0 to 14, with 0 being the strongest acid, 7 being neutral, and 14 being the strongest base.
- pH is measured on a logarithmic scale. This means that an acid of 5 is ten times stronger than an acid of 6. An acid of 4 is 100 times stronger than an acid of 5. Conversely, a base of 9 is ten times stronger than a base of 8, but a base of 10 is one hundred times stronger than a base of 8.

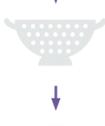
<https://www.usgs.gov/media/images/ph-scale-0>

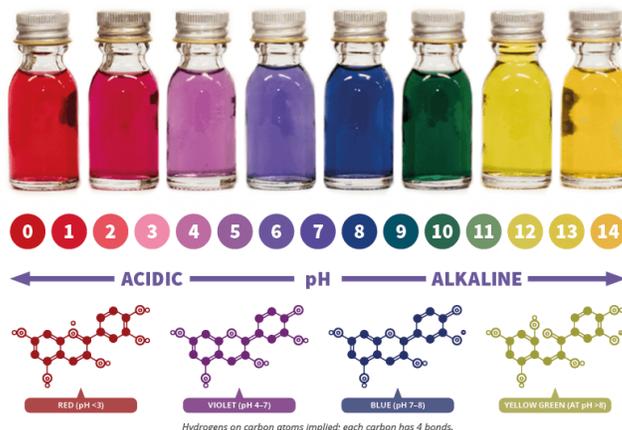
- Indicator solutions can use a color code to determine the strength of an acid or a base. You can purchase universal indicator solution, which turns a range of specific colors for each pH. Many people use litmus paper, which changes color to show the presence of an acid or base.
  - Red litmus paper turns blue in a base.
  - Blue litmus paper turns Red in an acid.
- Some naturally occurring materials like blueberries and red cabbage have a pigment called anthocyanin, which turns color in the presence of an acid or a base.

# MAKING AN INDICATOR FROM RED CABBAGE

The compounds that give red cabbage its colour can be extracted and used as a pH indicator solution. Here we look at the method and the colours!

## MAKING THE INDICATOR

-  1  
**ROUGHLY CHOP THE CABBAGE**
-  2  
**BOIL FOR A FEW MINUTES**
-  3  
**STRAIN AND LET COOL**
-  4  
**USE AS AN INDICATOR!**



The red cabbage extract can be used to determine whether substances are acidic or alkaline. The structures of the anthocyanin pigments which give the red cabbage its colour are subtly changed at varying pH. These different structures give a range of colours.



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<https://www.compoundchem.com/2017/05/18/red-cabbage/>

- If you mix an acid and a base together, it forms a chemical reaction. Sometimes these “neutralization” reactions can be dangerous. Generally, an acid mixed with a base produces water and a salt, which is a new solid that falls out of solution. That solid is called a “precipitate.”
- There are clues for when a chemical change is happening
  - Change in temperature
  - Change in color
  - Production of gas bubbles
  - Formation of an odor
  - Formation of a precipitate
- Mixing household chemicals can be dangerous. Never mix ammonia and bleach cleaning solutions because it forms a harmful gas.

## Science Vocabulary

- pH: the concentration of ions in a solution which determines if it is an acid or a base.
- Hydrogen: an atom that can form positive ions  $H^+$  or negative ions called hydroxide  $OH^-$  to form acids and bases.
- Acid: a sour tasting solution with  $H^+$  ions that corrodes metal. Its pH is  $<7$ .
- Base: a bitter tasting solution with  $OH^-$  ions that has a pH of  $>7$ .
- Neutral: a solution that is neither an acid nor a base, like pure water.
- Solution: a liquid homogenous mixture, like sweet tea, that is not chemically combined.
- Solvent: the larger amount of a liquid mixture that is usually water.
- Solute: the smaller amount of a liquid mixture.
- Concentration: the ratio or comparison of solvent to solution, such as 2:1, which is two parts of water to one part of the solute.
- Solubility: how well a material mixes in water. Most substances are soluble in water, but some are not, like cooking oil.
- Neutralization: the chemical reaction of an acid and base which forms gas bubbles, water, and a salt.
- Acid Rain: pollution in the atmosphere decreases the pH of slightly acidic rain water to lower levels that are harmful to plant and animal life.

## Printable Handouts

1. pH Handout for the Red Cabbage Indicator: <https://www.compoundchem.com/2017/05/18/red-cabbage/>

2. Blueberry Cabbage Magic
3. STEM TO GO

#### Kid-Tech Spot: Supplemental interactive websites and games

1. Test several household chemicals – virtually – no expense, no mess.  
[http://www.glencoe.com/sites/common\\_assets/science/virtual\\_labs/E22/E22.html](http://www.glencoe.com/sites/common_assets/science/virtual_labs/E22/E22.html)
2. Watch kid-friendly videos and do virtual labs on pH.  
<https://www.brainpop.com/science/matterandchemistry/phscale/>
3. How to waft (safely smell) a chemical using lab procedures. <https://www.youtube.com/watch?v=EQis0nnap74>

#### More Resources, just in case

1. Khan Academy's tutorial on acid's and bases is a good way to brush up on high school chemistry.  
<https://www.khanacademy.org/science/biology/water-acids-and-bases/acids-bases-and-ph/a/acids-bases-ph-and-buffers>

#### Resources for Teachers:

1. Khan Academy's tutorial on acid's and bases is a good way to brush up on high school chemistry.  
<https://www.khanacademy.org/science/biology/water-acids-and-bases/acids-bases-and-ph/a/acids-bases-ph-and-buffers>
2. Lesson plans in chemistry: <http://www.middleschoolchemistry.com/lessonplans/chapter6/lesson8>
3. Another lesson plan for chemistry: <http://www.middleschoolchemistry.com/lessonplans/chapter6/lesson10>

#### In the News

1. A short article about how acid rain and air quality impact forest health.  
<http://listening.coweeta.uga.edu/articles/acid-rain-and-air-quality>
2. A short article about ocean acidification. <https://oceanservice.noaa.gov/facts/acidification.html>

#### On the Road

Piedmont: NC Museum of Life and Science upstairs Chem Lab

#### Other Lessons and Reference Materials Used to Develop this Unit

<https://sciencing.com/bases-used-common-household-products-8107632.html>  
<https://www.steampoweredfamily.com/activities/acids-bases-ph-chemistry-experiment/>  
<https://www.compoundchem.com/2017/05/18/red-cabbage/>  
<https://sciencebob.com/lemon-chemistry-an-acid-base-experiment/>  
<http://www.middleschoolchemistry.com/lessonplans/chapter6/lesson10>  
[https://www.teachengineering.org/content/cub\\_/activities/cub\\_air/cub\\_air\\_lesson06\\_activity2\\_worksheet.pdf](https://www.teachengineering.org/content/cub_/activities/cub_air/cub_air_lesson06_activity2_worksheet.pdf)  
[http://www.glencoe.com/sites/common\\_assets/science/virtual\\_labs/E22/E22.html](http://www.glencoe.com/sites/common_assets/science/virtual_labs/E22/E22.html)  
[https://www.teachengineering.org/content/cub\\_/activities/cub\\_air/cub\\_air\\_lesson06\\_activity2\\_worksheet.pdf](https://www.teachengineering.org/content/cub_/activities/cub_air/cub_air_lesson06_activity2_worksheet.pdf)  
[https://www.usgs.gov/special-topic/water-science-school/science/ph-and-water?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/special-topic/water-science-school/science/ph-and-water?qt-science_center_objects=0#qt-science_center_objects)  
<https://www.coolantconsultants.com/mix-ratios-percentages>  
<http://hyperphysics.phy-astr.gsu.edu/hbase/Chemical/acidbase.html>  
<https://www.scientificamerican.com/article/shine-bright-like-a-penny/>  
<https://www.scientificamerican.com/article/bring-science-home-cabbage-chemistry/>  
<https://www.youtube.com/watch?v=EQis0nnap74>  
<https://sites.jmu.edu/chemdemo/2011/06/14/lemon-fizz/>  
<https://sites.jmu.edu/chemdemo/2011/06/14/red-cabbage-indicator/>  
<https://www.youtube.com/watch?v=4Q6k822lSm4>  
<https://www.youtube.com/watch?v=s9kAiph27aI>  
<https://pubs.acs.org/cen/environment/88/8823sci4.html>