Acids and Bases
An Interactive Activity

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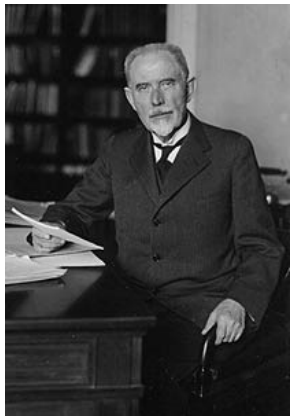
Acids and Bases

- **Svante August Arrhenius (1859 –1927)**
  - **Acid produces hydrogen ions in water solution.**
- **Johannes Nicolaus Brønsted (*1879-1947) and* Thomas Martin Lowry (1874-1936)**
  - **An acid-base reaction consists of the transfer of a proton (or hydrogen ion) from an acid to a base**

pH

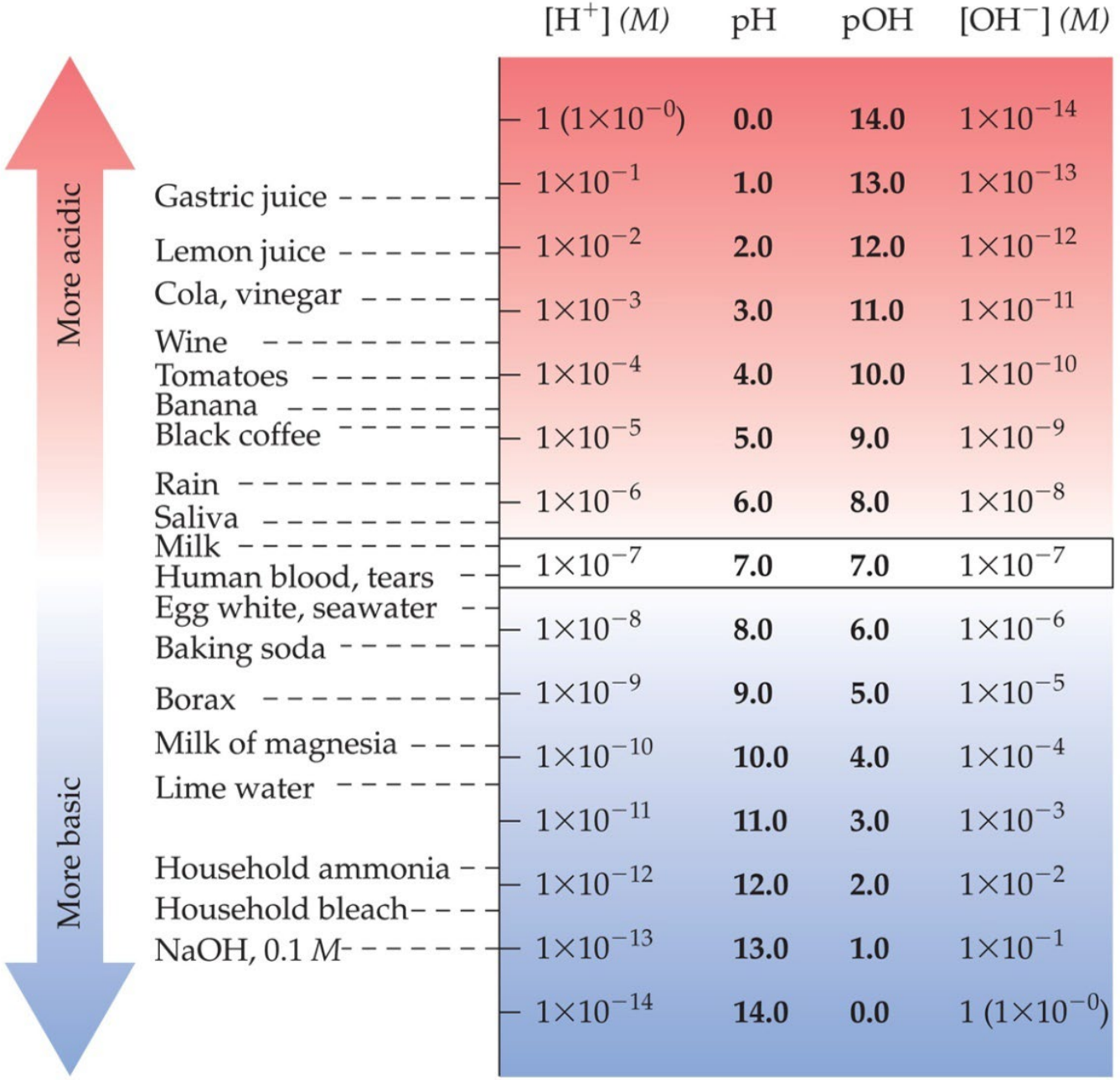
- First introduced by Danish chemist Søren Peder Lauritz Sørensen (1868-1939), the head of the Carlsberg Laboratory's Chemical Department, in 1909
- pH means 'the power of hydrogen'.
- Each value of pH means the H^+ concentration changes by a factor of 10
- As the H^+ concentration decreases, the OH^- concentration increases



pH 1		pH 7		pH 14
strong acid	weak acid	neutral	weak base	strong base

he pH scale according to the late Dr. Hubert Alyea, Princeton University

pH values for some common substances



$[H^+]$ (*M*)	pH	pOH	$[OH^-]$ (*M*)
$1\ (1\times10^{-0})$	**0.0**	**14.0**	1×10^{-14}
1×10^{-1}	**1.0**	**13.0**	1×10^{-13}
1×10^{-2}	**2.0**	**12.0**	1×10^{-12}
1×10^{-3}	**3.0**	**11.0**	1×10^{-11}
1×10^{-4}	**4.0**	**10.0**	1×10^{-10}
1×10^{-5}	**5.0**	**9.0**	1×10^{-9}
1×10^{-6}	**6.0**	**8.0**	1×10^{-8}
1×10^{-7}	**7.0**	**7.0**	1×10^{-7}
1×10^{-8}	**8.0**	**6.0**	1×10^{-6}
1×10^{-9}	**9.0**	**5.0**	1×10^{-5}
1×10^{-10}	**10.0**	**4.0**	1×10^{-4}
1×10^{-11}	**11.0**	**3.0**	1×10^{-3}
1×10^{-12}	**12.0**	**2.0**	1×10^{-2}
1×10^{-13}	**13.0**	**1.0**	1×10^{-1}
1×10^{-14}	**14.0**	**0.0**	$1\ (1\times10^{-0})$

Visualizing pH

Reference: http://www.chymist.com/Visualizing%20pH.pdf

- **Students do not necessarily understand pH.**
- **A hands-on activity provides some visual recognition and understanding.**
- **Allows for discovery through discussions.**
- **Low cost, easy to set-up.**
- **Once set-up, materials can be used for up to several days. (Buffer solutions are stable for more than one year.)**
- **Follow-up as homework assignment.**

Preparation of Red Cabbage Paper

- **Use 11 cm or 12 cm filter paper circles, coffee filters or similar.**
- **Place pieces of red cabbage in a blender with ethyl rubbing alcohol (70% ethyl alcohol in water) or a 50% mixture of denatured alcohol with water.**
- **DO NOT FILL BLENDER JAR MORE THAN 1/3 FULL.**

  SAFETY NOTE: Ethyl alcohol is flammable. Keep it away from flames. Do not fill the blender more than one-third full to avoid splashing any alcohol from the blender. Sparks from the blender motor can ignite any spilled or splashed alcohol.
- **Blend until smooth. Strain the liquid through several layers of cheesecloth or a very fine sieve.**
- **Dip filter paper in the red cabbage juice.**
- **Lay out in a single layer on clean table tops, or tables covered with clean plastic, to dry.**
- **Store in a Ziploc type bag in a cool dark place. The red cabbage paper will keep for 6 months or longer with no odor or spoilage.**

Set-up the Solutions

- **Use small plastic cups (about 100 mL)**
- **Use a black marker to label each plastic cup with the solution it will contain.**
  - **For pH solutions, write “pH 1”, “pH 2”, etc.**
  - **For household materials write the name of the product.**
- **Place about 5 to 10 mL of each solution in the proper labeled cup.**
- **For solids or thick gels or pastes, place some of the material in the labeled plastic cup, add about 10 mL of water and stir to mix.**
- **Add a stirring rod to each cup.**

Acids, Bases, and pH

- **Acids, bases, and pH using red cabbage paper**
  - **Buffers for reference**
  - **Solutions of household products**

Instructions at
http://www.chymist.com/Visualizing%20pH.pdf

- **Illustrate indicator colors using serial dilutions to observe color changes**

Discuss pH's of various household materials

Taste an Acid/Taste a Base

- **Safety Precautions:**

  This activity must be performed in a clean, contamination free area, away from laboratory chemicals.

  All materials used must be food grade or better and should be newly purchased.

  If stored, they must be stored away from any possible source or contamination, preferably at home.

- **Materials needed:**

  2 pitchers (plastic preferred). One pitcher should be labeled "ACID" and one pitcher labeled "BASE"

  sour salt (citric acid) Available in supermarkets or organic food stores

  baking soda (sodium bicarbonate, $NaHCO_3$)

  water

  90 mL (3 ounce) drinking cups

  stirring rods – large wood or plastic kitchen spoons

  Optional:

  - **a third pitcher**
  - **Potassium citrate, $K_3C_6H_5O_7$ – available at Natural Food Stores (Must be food grade or better.)**

Taste an Acid/Taste a Base

Procedure:

- **Prepare an acid solution.**
  - **Fill the ACID pitcher with drinking water.**
  - **Add sour salt (citric acid), small amounts at a time, stirring and tasting until a suitable sour tasting solution is obtained.**
  - **Cover the pitcher until ready to use.**
- **Prepare a base solution.**
  - **Fill the BASE pitcher with drinking water.**
  - **Add baking soda (sodium bicarbonate), small amounts at a time, stirring and tasting until a suitable bitter tasting solution is obtained.**
  - **Cover the pitcher until ready to use.**
- **Optional: Prepare a Buffer Solution**
  - **Fill the BUFFER pitcher with drinking water.**
  - **Add sour salt (citric acid), small amounts at a time, stirring and tasting until a suitable sour tasting solution is obtained.**
  - **Add about ½ amount of potassium citrate**
  - **Cover the pitcher until ready to use.**

Taste an Acid/Taste a Base

- **Pour about 5 mL of acid and base solutions into separate paper cups. Each student should receive one of each solution.**
- **Instruct the students to SIP a SMALL AMOUNT of the BASE solution. Ask them to describe the taste. If necessary, students may take a second taste of the solution. They should NOT drink all the solution.**
- **Instruct the students to SIP a SMALL AMOUNT of the ACID solution. Ask them to describe the taste. If necessary, students may take a second taste of the solution. They should NOT drink all the solution.**
- **Optional: Instruct the students to SIP a SMALL AMOUNT of the BUFFER solution. Ask them to describe the taste. How does that compare to the ACID solution? If necessary, students may take a second taste of the solution. They should NOT drink all the solution.**
- **Discard any remaining solutions and the paper cups.**

Activities and experiments can be found at

http://www.chymist.com

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