CHEMISTRY

ACIDS AND BASES

Water (H_2O), is composed of hydrogen ions (H^+) and hydroxide ions (OH^-). When a chemical is mixed with water it is called an ***AQUEOUS*** solution.

ACIDS

- An acid is an aqueous solution that has an excess of **hydrogen** ions.

- The chemical formula for an acid can always be recognized as those that start with an "H".

- ***Ex:*** HCl H_2SO_4 H_3PO_4

- An acid can be recognized as those chemicals that give a hydrogen ion (***or proton***) when in solution. Some acids give off a single proton and are called **"*monoprotic*".** Other acids have multiple protons to give off; these are called ***"diprotic"*** or ***"polyprotic"***.

- In order for an acid to display its properties it must ***dissociate*** (or break apart). Weak acids (like lemon juice) don't dissociate completely when in solution. This means that they are typically less harmful then strong acids.

- Acids are chemicals that have a sour taste (lemons - citric acid) and will tingle when you touch them.

- Acids are extremely reactive with metals. Some really strong acids will burn a hole right through a piece of metal.

- An acid is created by mixing a ***non-metal oxide*** with water.

Ex: $SO_3 + H_2O \longrightarrow H_2SO_4$

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BASES

- A base is an aqueous solution that has an excess of **hydroxide** ions.

- The chemical formula for a base can always be recognized as those that end with an "**OH**".

- ***Ex:*** **KOH** **$Mg(OH)_2$** **NaOH**

- Bases are chemicals that have a bitter taste (soap) and will feel slippery when you touch them.

- Bases are extremely reactive with organics (non-metal compounds) Some really strong bases will burn a hole right through organic material (like your hand).

- A base is created by mixing a ***metal oxide*** with water.

Ex: **MgO + H_2O ⟶ $Mg(OH)_2$**

Here's the difference ... ***Basic***ally:

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Aweful Acids

Brutal Bases

1:40

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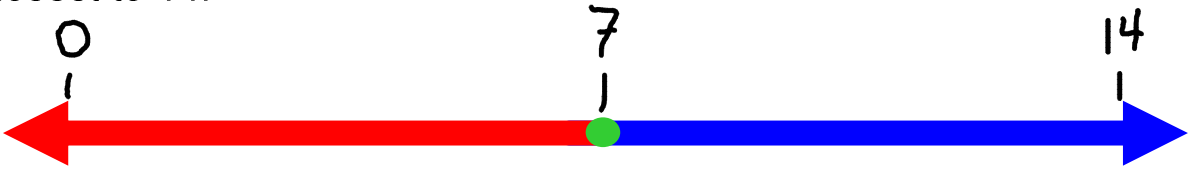
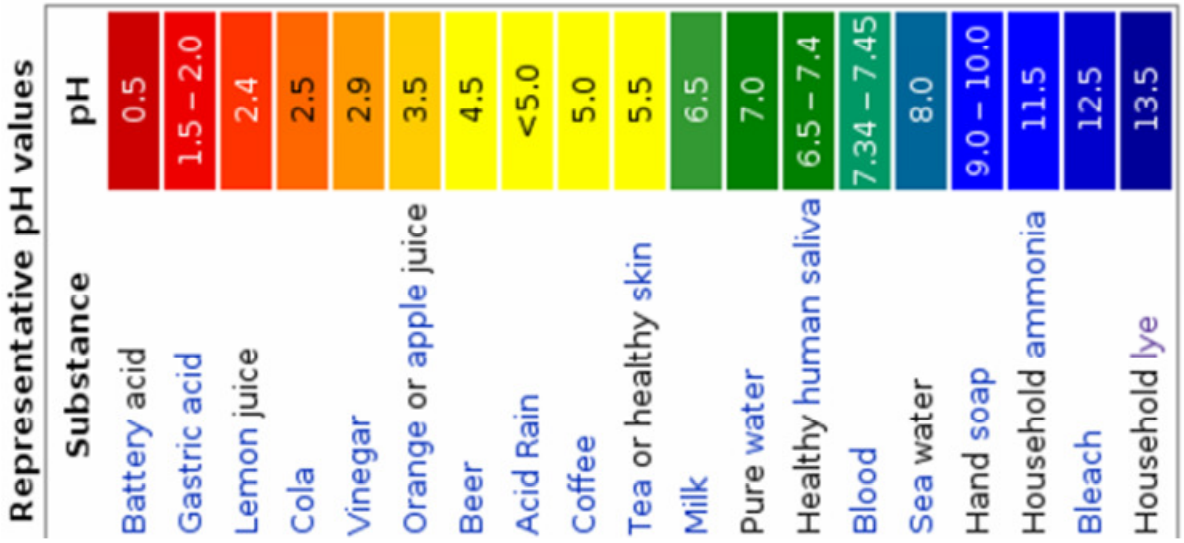
THE pH SCALE

The pH scale is a scale used to measure how powerful an acid or base is. The scale ranges from 0 to 14. Acids occupy the low end of the scale from 0 to 7 with the strongest acids close to zero. Bases occupy the top end of the scale from 7 to 14 with the strong bases closest to 14.





The pH scale is logarithmic. This means that each unit on the scale is different by a factor of 10 (a base with a pH of 14 is 10 times stronger than a base with pH 13).

Ex: *How many times stronger is hydrochloric acid (pH = 1) than acid rain (pH = 5)?*

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INDICATORS

A acid-base indicator is a chemical used to determine whether an unknown liquid is either acidic or basic. There are many chemical indicators but three of the most popular are:

	Reaction with ACID	Reaction with BASE
Litmus Paper		
Phenolpthalene		
Bromthymol Blue		

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ACIDS AND BASES

Learning Check ...

1. Identify each of the following as an acid or base:
   - **a)** potassium hydroxide
   - **b)** $HClO_3$
   - **c)** $Mg(OH)_2$
   - **d)** HNO_3

2. What is meant by the term "acid indigestion"?

3. What is the meaning of the term pH?

4. What would you expect as the appropriate pH value for the following?
   - **a)** A concentrated Acid
   - **b)** A concentrated Base
   - **c)** A diluted Acid
   - **d)** A diluted Base

5. How much more acidic is a solution with a pH of 4.5 than one with a pH of 6.5?

6. What happens to the pH of an acid when water is added to it?

7. Predict what kind of solution (acidic or basic) will be formed in the following reactions:
   - **a)** bromine monoxide + water $\longrightarrow$
   - **b)** nickel(II)oxide + water $\longrightarrow$
   - **c)** potassium oxide + water $\longrightarrow$

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ACIDS AND BASES

Learning Check ...

1. According to the Arrhenius theory of acids and bases, what characterizes an acid? What characterizes a base?
2. Acids and bases are commonly found in the home. They can be identified by their properties.
   a. Name two foods that contain acidic substances.
   b. Name two household items that contain basic substances.
3. Use Table 10.1 to create a graphic organizer, such as a Venn diagram, that compares the properties of acids and bases.
4. Identify each substance as an acid or an base.
   a. $HBr(aq)$ d. $HClO_4(aq)$ g. $Sr(OH)_2(aq)$
   b. $KOH(aq)$ e. $Ca(OH)_2(aq)$ h. $CsOH(aq)$
   c. $H_3PO_4(aq)$ f. $HNO_3(aq)$
5. When one drop of phenolphthalein is added to a clear colourless solution, the solution becomes pink. If another sample of the solution is tested with a piece of blue litmus paper, what observation would you expect? Explain your answer.
6. For each of the following, identify whether the hydrogen ion concentration is higher or lower than the hydroxide ion concentration.
   a. a solution with a pH of 4
   b. lemon juice
   c. a solution of sodium hydroxide
7. Summarize the difference between "strong" and "concentrated" when describing a solution of an acid. Give examples to illustrate this difference.
8. The terms "concentrated" and "dilute" can be used to describe acids and bases.
   a. Give an example of a dilute solution of a strong base.
   b. Give an example of a concentrated solution of a weak acid.
9. The pH of one type of soft drink is 3.0. The soft drink contains carbonic acid, $H_2CO_3(aq)$, and phosphoric acid, $H_3PO_4(aq)$. Are these acids strong or weak? Give reasons for your answer.
10. Predict the relative strengths of the following acids: hypochlorous acid, $HClO(aq)$; chlorous acid, $HClO_2(aq)$; chloric acid, $HClO_3(aq)$; perchloric acid, $HClO_4(aq)$. Explain your reasoning.
11. Draw diagrams that show the difference between strong and weak versus concentrated and dilute bases.
12. Why are the safety warnings for investigations that use strong acids or bases much more strict than those that use weak acids or bases?

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Learning Check ...

1. K/U The Arrhenius theory of acids and bases describes acids and bases in terms of the ions formed when the compounds are dissolved in water.
   a. According to the Arrhenius theory, can a substance that does not contain hydrogen atoms be an acid? Explain your answer.
   b. Is every substance that contains hydrogen atoms an acid? Explain your answer.
2. K/U How can the properties of an acid be explained? Why does glucose, $C_6H_{12}O_6(aq)$, not have acidic properties even though 1 mol of glucose contains six times as many hydrogen atoms as 1 mol of sulfuric acid, $H_2SO_4(aq)$?
3. C Draw diagrams to show the difference between ionization and dissociation.
4. K/U What is a universal indicator? How is it useful in a laboratory?
5. T/I Describe two different tests you could perform in a laboratory to determine if an unknown compound is an acid.
6. T/I Three aqueous solutions were tested using litmus paper. The results of these tests are given in the table below. Identify each solution as neutral, acidic, or basic.

Reactions with Litmus Paper

Litmus Paper	Solution A	Solution B	Solution C
Red	Paper turns blue.	Paper stays red.	Paper stays red.
Blue	Paper stays blue.	Paper stays blue.	Paper turns red.

7. A A solution of household vinegar and water is sometimes used to clean glass. Marble is made up primarily of calcium carbonate, $CaCO_3(s)$. Why should vinegar never be used to clean marble tiles?
8. K/U The pH scale measures the acidity and basicity of solutions.
   a. What pH values correspond to acidic solutions?
   b. What pH values correspond to basic solutions?
9. A The pH of some common beverages are as follows: buttermilk, pH 4.5; coconut milk, pH 6.5; cranberry juice, pH 2.4; lime juice, pH 2.2; orange juice, pH 4.0.
   a. Arrange the beverages in order of increasing acidity.
   b. Predict how the taste of these beverages would compare, based on your arrangement.
10. T/I Explain why there are no molecules of hydrogen chloride in a 1 mol/L solution of hydrochloric acid, HCl(aq). What is present in the solution?
11. K/U Consider the following substances: $H_2SO_4(aq)$, $NaHCO_3(s)$, KOH(aq), HCl(aq), oxalic acid, aqueous ammonia.
    a. Which (if any) is a strong acid?
    b. Which (if any) is a weak base?
12. K/U What does it mean when an aqueous solution of an acid is described as "weak"?
13. T/I Consider 0.1 mol/L solutions of hydrochloric acid, HCl(aq); acetic acid, $CH_3COOH(aq)$; and ammonia, $NH_3(aq)$. List these solutions in order of increasing hydrogen ion concentration. Explain your reasoning.
14. T/I What piece of laboratory equipment could you use to distinguish between a strong base and a weak base? Describe how you would do this.
15. A Citric acid and most of the other acids found in nature are weak acids. Explain why this is a good thing for humans.
16. C Is it possible to have a concentrated solution of a weak acid? Explain your answer in a way that a student in ninth grade could understand you.