Chapter 16

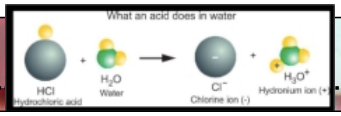
Acids, Bases, Neutrals And Indicators

What is an acid?

- A compound that dissolves in water and produces **hydronium ions (H_3O^+).**

Acid + Water → H_3O^+ + ionS

- Comes from the Latin word *acidus* that means "sharp" or "sour"
- Example: HCl + H_2O --> Cl^- + H_3O^+



1. Introduction to Aqueous Acids

Introduction to Aqueous Acids

Strong vs. Weak acids

- As an acid dissolves in water, its molecules break apart & produce H^+ (or H_3O^+)
- If **ALL** of the molecules break apart, the acid is considered a **strong** acid.
  - Examples of strong acids are sulfuric acid, nitric acid, hydrochloric acid.
- If only **a few** of the molecules break apart, the acid is considered a **weak** acid.
  - Examples of weak acids include acetic acid, citric acid, carbonic acid

Acidic Properties

- pH **less** than 7
- Taste **sour**
- May change the color of certain compounds
- React with metals to produce hydrogen gas (H_2)
- Can be very **corrosive**, meaning they may destroy metals & burn skin

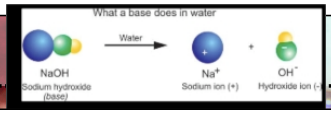
Examples of Acids

What is a base?

- A compound that dissolves in water to produce **hydroxide ions (OH^-).**

Base + Water → OH^- + ions

- Another word for base is **alkali**.
- Example: $NaOH + H_2O \rightarrow Na^+ + OH^-$



2. Introduction to Aqueous Bases

Introduction to Aqueous Bases

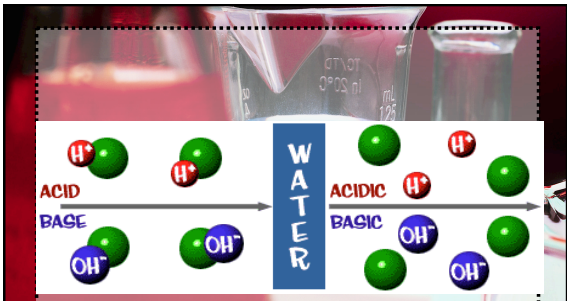
Strong vs. Weak Bases

- As with acids, when **ALL** of the molecules break apart in water to produce OH^-, the base is called a **strong** base.
  - Examples of strong bases are sodium hydroxide, calcium hydroxide, potassium hydroxide.
- If only a **few** of the molecules break apart, the base is called a **weak** base.
  - Examples of weak bases include ammonia, magnesium hydroxide, aluminum hydroxide.

Basic Properties

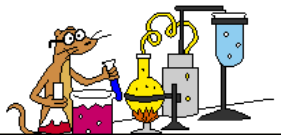
- pH **greater** than 7
- Taste **bitter**
- Feel **slippery**, like soap
- May change the color of certain compounds
- Can be very **corrosive**, meaning they may destroy metals & burn skin

Examples of Bases



ACIDS AND BASES

- Look around. Every liquid you see will probably be either an acid or a base.
- The only exception would be distilled water.
- Distilled water is just water. That's it.
- But what about baking soda? Vinegar? Scientists use something called the "pH" scale to measure how acidic or basic a liquid is.



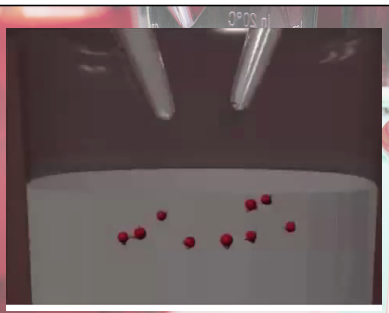
Acids + Bases = ?

- What do you think happens if you add acids & bases together?
- They **neutralize** each other!
- These reactions occur when the positive ions from the base combine with the negative ions from the acid.

Acids + Bases = ?

- This reaction is really important - without it, the acid in your stomach would eat away your entire digestive tract.
- As the fluids & acids leave your stomach, the pancreas & liver produce bicarbonate (a base) to neutralize the stomach acid.

3. Acids + Bases= Neutralization



Acids & Bases Unite!

- In fact, there's a little more to it than that.
- When acids & bases combine, the positive hydrogen ion (H^+) from the acid combines with the negative hydroxide ion (OH^-)from the base.
- This forms water (H_2O) and a salt with the remaining ions.

Acid + Base → Water + Salt

- Example: HCl + NaOH --> H_2O + NaCl

Acids & Bases Unite!

- Picture this…
- It's summertime & very hot outside, but you're out swimming in the beautiful warm ocean.
- Suddenly, OUCH.
- A giant jellyfish stings your leg.
- What do you do?
- Well, besides screaming like an idiot, you run (or rather hop) to the lifeguard for help.
- What do they do?
- Pour vinegar on the sting.
- Why do they do this???

And now Tim & Moby:

- Acids & Bases… it's in your Cabbages in Chemistry Packet
- Click here

BrainPop: Acids and Bases

1. Which of the following substances is acidic?
a. Baking soda b. Lemon-lime soft drink c. Distilled water d. Bar of soap

2. What happens immediately after you dissolve acid in water?
a. Positively charged hydrogen atoms are released
b. Hydronium ions are released
c. Negatively charged hydrogen atoms are released
d. Neutrally charged hydrogen atoms are released

3. Acids are caustic to the touch. In this context, what does "caustic" mean?
a. Stinging or burning b. Pleasant c. Sarcastic d. Gentle

4. A hydronium ion is like a(n) _____ molecule with an extra hydrogen atom.
a. Acid b. Base c. Water d. Vinegar

5. What substance would do the best job of cleaning pots and pans?
a. A substance with a pH of 7 b. A substance with a pH of 2
c. A substance with a pH of 4 d. A substance with a pH of 8

6. What is a property of bases?
a. Slippery touch b. Sour taste
c. Ability to dissolve metal d. Ability to form hydronium ions

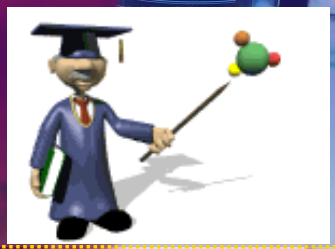
7. How do acidic solutions taste?
a. Delicious b. Sweet c. Bitter d. Sour

8. Which of the following substances is basic?
a. Apple juice b. Ginger ale c. Baking soda d. Distilled water

9. pH stands for:
a. Potency of hydrogen b. Plurality of hydrogen
c. Potential of hydrogen d. Pleurisy of hydrogen

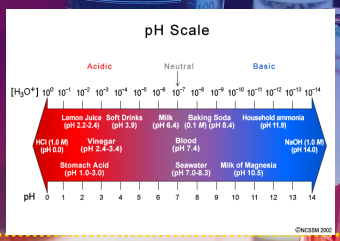
10. What do acids and bases have in common?
a. They both eat away at metal
b. They can both conduct electricity
c. They both have a sour taste
d. They both form positively charged ions when dissolved in water

ACIDS AND BASES and the pH scale

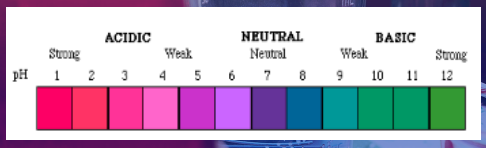


The pH Scale

- The scale goes from "0" to "14".
- Distilled water is 7 (right in the middle).



ACIDS AND BASES

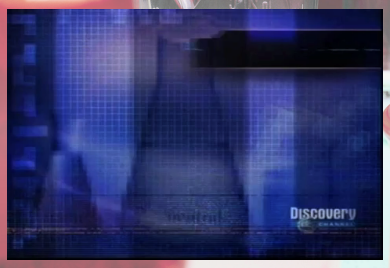


- When you start looking at the pH of chemicals the numbers go to the extremes.

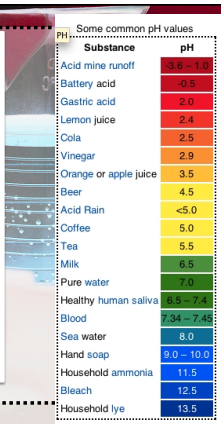
ACIDS AND BASES

- If you ever go into a chemistry lab, you could find solutions with a pH of "1" and others with a pH of "14".
- Those chemicals are very dangerous.
- There are pH values higher than 14 and lower than 0, but let's just start with 0-14.

4. Properties of Acids & Bases



- pH measures the **acidity** of a solution,
- or how many **hydronium ions** are in the solution.
- The pH scale ranges from **0-14** A pH of 7 is **neutral**.
- **Neutral** means the solution is neither acidic nor basic, like distilled water.



Definitions to Know:

- **ACID:** A solution that has an excess of **H+** ions. It comes from the Latin word "acidus" which means "sharp".
- **BASE:** A solution that has an excess of **OH-** ions. Another word for base is **ALKALI.**
- **NEUTRAL**: A solution which has a pH of 7. It is neither acidic nor basic. (the neutral range is: **6.5-8.5**)

Definitions to Know:

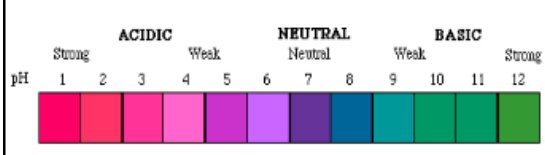
- **STRONG ACID:** An acid which has a very low pH . **(0-4)**
- **STRONG BASE**: A base which has a very high pH. **(10-14)**

Definitions to Know:

- **WEAK ACID**: An acid that only partially ionizes in an aqueous solution.
- That means not every molecule breaks apart.
- They usually have a pH closer to 7 **(4-6)**
- **WEAK BASE**: A base that only partially ionizes in an aqueous solution.
- That means not every molecule breaks apart.
- They usually have a pH close to 7 **(8 -10)**
- **AQUEOUS**: A solution which is mainly water. Think about the word aquarium. **AQUA** means water.

What is pH?

- **Acids** have a pH less than 7
  - Strong acids: very low pH, 0-4
  - Weak acids: low pH, 4-6
- **Bases** have a pH greater than 7
  - Strong bases: very high pH, 10-14
  - Weak bases: high pH, 8-10



ACIDS AND BASE

additional info- no notes needed!

ACIDS AND BASES

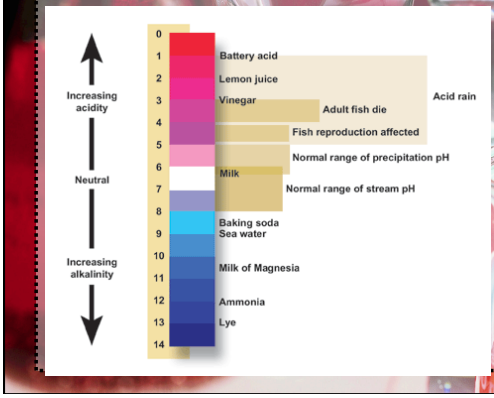
- **Acidic bee stings** (pH 5.0-5.5) can be soothed, i.e. neutralized by calamine lotion, which is a mild alkali based on zinc oxide
- and you can also use baking soda ('bicarb of soda' = sodium hydrogen carbonate, another mild alkali).

ACIDS AND BASES

- **Wasp stings**, supposed to be alkaline, but apparently not! - are almost neutral at pH 6.8-6.9 but are 'traditionally' treated with vinegar which is a weak acid (and then calamine too!).

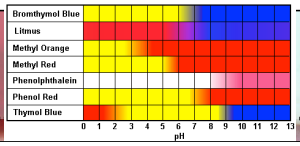
ACIDS AND BASES

- This may be "folklore", however, what is known is that bees and wasps have glands that can secrete either acids or alkalis
- and ants sting venom often contains methanoic acid (*'formic acid'*) with a pH of 3
- and is presumably 'soothed' by mild alkalis and just further confuse matters, many people claim the 'folklore' remedies work!



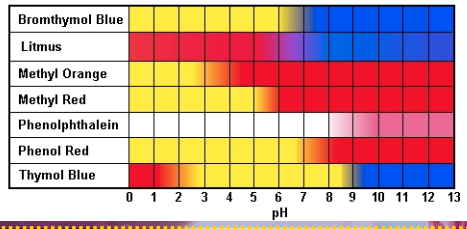
What is an indicator?

- **Certain chemicals turn different colors at different pH.**
- **These chemicals are called pH indicators and they are used to determine pH.**
- **Red cabbage juice is an indicator you can make at home.**
- **Red & blue litmus papers are also used to test pH.**



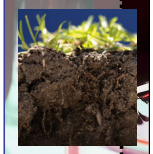
Indicators: PLEASE WRITE THIS DOWN:

An indicator is not an acid, base or neutral!
It is an indicator of those chemicals!



pH in the Environment

- Living things depend on having a steady pH in their environment.
- The pH of soil directly affects nutrient availability for plants.
- Most plants prefer a slightly acidic soil with a pH between 6.5 and 7.0.
- In highly acid soils too much aluminum, manganese and other elements may leach out of soil minerals and reach concentrations that are toxic to plants.



pH in the Environment

- The pH of water directly affects aquatic life too.
- Most freshwater lakes, streams, and ponds have a natural pH in the range of 6 to 8.
- Most freshwater fish can tolerate pH between 5 and 9 although some negative effects appear below pH of 6.
- Trout are among the most pH tolerant fish and can live in water with a pH from 4 to 9.5.

Tim & Moby: The pH Scale

- Click here

BrainPop: pH Scale

1. Which of these substances is acidic?
   a. Tap water b. Lemon wedge c. Floor cleaner d. Box of baking soda
2. What is the most likely pH of a tube of toothpaste? a. 3 b. 5 c. 7 d. 9
3. How is a standard hydrogen atom different from a hydrogen ion?
   a. A hydrogen ion has an extra electron
   b. A hydrogen ion is missing an electron
   c. A hydrogen ion has an extra proton
   d. A hydrogen ion is missing a proton
4. What might happen if you mixed a strong acid with an equally strong base?
   a. You would see an explosive chemical reaction
   b. The acid would destroy the base
   c. The base would destroy the acid
   d. You'd wind up with a pH-neutral substance
5. An extremely strong base would have a pH of: a. 1 b. 7 c. 9 d. 14
6. What might happen if buffers did not exist within the human body?
   a. Our blood and other bodily fluids might become too acidic or basic
   b. Our stomach acid would not be able to break down food
   c. We would not be able to process glucose within our cells
   d. We would not be able to inhale oxygen into our lungs
7. This piece of pH paper has been dipped into: [Blue pH paper]
   a. An acid b. A base c. A pH-neutral substance d. A buffer
8. Why do metals dissolve when you dip them in acid? [Dissolving metal]
   a. The buffers in the metal are eaten away by the acid
   b. The electrons in the metal are stripped away by hydrogen ions
   c. The hydrogen ions in the acid react with the hydroxyl ions in the metal
   d. The acid reacts with the basic metal to form carbon dioxide gas and salt
9. What might happen if acidic chemicals were emitted into the air by factories? Choose the best answer.
   a. The acid would destroy metallic elements in the air
   b. The acid would be neutralized by bases within clouds
   c. Acid rain might destroy ecosystems and farmland
   d. Violent chemical reactions would take place within the atmosphere
10. Healthy environments for life have a pH closest to:
    a. 1 b. 3 c. 7 d. 10

Acids, Bases, & YOU!

- Many reactions, such as the ones that occur in your body, work best at specific pH values.
- For example, acids and bases are very important in the reactions involved in digesting food.
- As you may know, the stomach secretes hydrochloric acid (HCl), a strong acid (pH 1.4).

Acids, Bases, & YOU!

- The level of acidity in our stomachs is necessary to break down the protein molecules in food so they can be absorbed.
- A mucus lining in the stomach protects it from the acid produced.

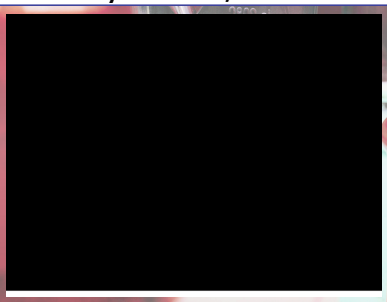
Acids, Bases, & YOU!

- Very spicy foods, stress, or poor diet can cause the stomach to produce too much acid, or allow stomach acid to escape from the stomach.
- An **ulcer** may occur when the mucus lining of the stomach is damaged.
- Stomach acid can then attack the more sensitive tissues of the stomach itself.

Acids, Bases, & YOU!

- The uncomfortable condition called heartburn is caused by excessive stomach acid backing up into the esophagus.
- Eating very large meals can lead to heartburn because an overflowing stomach pushes acid up into the esophagus.

5. Summary: Acids, Bases & You



Acid & Base Review

1. Acids release positively charged **hydrogen** atoms when they are dissolved in water. When those hydrogen atoms combine with **water** molecules, hydronium ions form.
2. The pH scale gives you a measure for identifying acids & bases. pH stands for **potential of hydrogen** and the scale ranges from 0 to 14.
3. A substance with a pH of exactly 7, like distilled water, is called pH **neutral**.
4. Bases also contain hydrogen, but they form **hydroxide** ions when they dissolve in water.

6. It's all about the song…

The Bromthymol Blues

Music & Lyrics © 2005, Mark Rosengarten


Remember,
if you're not part of the solution,
you're part of the precipitate.