

## Chapter 16

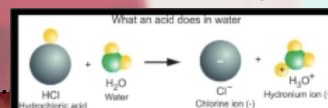
### Acids, Bases, Neutrals And Indicators

#### What is an acid?

- A compound that dissolves in water and produces **hydronium ions ( $\text{H}_3\text{O}^+$ )**.



- Comes from the Latin word *acidus* that means "sharp" or "sour"
- Example:  $\text{HCl} + \text{H}_2\text{O} \rightarrow \text{Cl}^- + \text{H}_3\text{O}^+$



#### 1. Introduction to Aqueous Acids

##### Introduction to Aqueous Acids

#### Strong vs. Weak acids

- As an acid dissolves in water, its molecules break apart & produce  $\text{H}^+$  (or  $\text{H}_3\text{O}^+$ )
- 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.
  - Animation: [HCl versus HF](#)

#### Acidic Properties

- pH **less** than 7
- Taste **sour**
- May change the color of certain compounds
- React with metals to produce hydrogen gas ( $\text{H}_2$ )
- Can be very **corrosive**, meaning they may destroy metals & burn skin

#### Examples of Acids

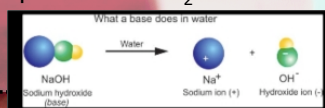


## What is a base?

- A compound that dissolves in water to produce **hydroxide ions ( $\text{OH}^-$ )**.



- Another word for base is **alkali**.
- Example:  $\text{NaOH} + \text{H}_2\text{O} \rightarrow \text{Na}^+ + \text{OH}^-$



## 2. Introduction to Aqueous Bases

### Introduction to Aqueous Bases

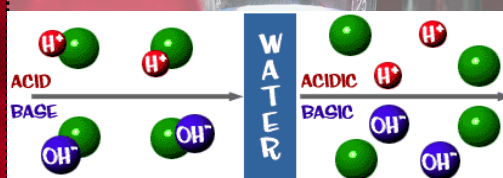
## Strong vs. Weak Bases

- As with acids, when **ALL** of the molecules break apart in water to produce  $\text{OH}^-$ , 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.



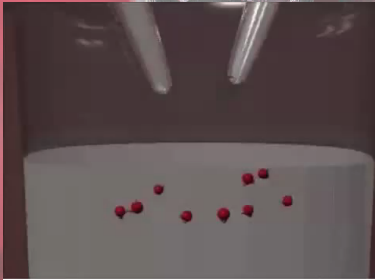
## Acids + Bases = ?

- 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  $\rightarrow$  Water + Salt**

- Example:  $HCl + NaOH \rightarrow H_2O + NaCl$

## 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 pg 6 in your little book
- [Click here](#)


**BrainPOP ACIDS AND BASES** December 7, 2012 Elaine

**SCORE: 10/10**

- Which of the following substances is acidic?
  - ☐ A. Sugar
  - ☒ B. Lemon juice
  - ☐ C. Baking soda
  - ☐ D. Distilled water
- What happens immediately after you dissolve acid in water?
  - ☒ A. Positively charged hydrogen atoms are released
  - ☐ B. Negatively charged hydrogen atoms are released
  - ☐ C. Positively charged hydrogen atoms are released
  - ☐ D. Negatively charged hydrogen atoms are released
- Acids are usually in the form of \_\_\_\_\_ molecules with an extra hydrogen atom.
  - ☐ A. Acid
  - ☐ B. Base
  - ☒ C. Water
  - ☐ D. Sugar
- Which substance would be the best for cleaning pipes and drains?
  - ☐ A. A substance with a pH of 1
  - ☐ B. A substance with a pH of 2
  - ☐ C. A substance with a pH of 8
  - ☒ D. A substance with a pH of 13
- What is a property of bases?
  - ☒ A. Slippery touch
  - ☐ B. Sour taste
  - ☐ C. Ability to donate metal
  - ☐ D. Ability to form hydroxide ions
- How do acids behave in water?
  - ☐ A. Ionizes
  - ☐ B. Dissolves
  - ☐ C. Boils
  - ☒ D. Freezes
- Which of the following substances is basic?
  - ☐ A. Apple juice
  - ☐ B. Vinegar
  - ☒ C. Baking soda
  - ☐ D. Distilled water
- pH stands for:
  - ☐ A. Potency of hydrogen
  - ☐ B. Potency of hydroxide
  - ☒ C. Potential of hydrogen
  - ☐ D. Potency of hydroxide
- What do acids and bases have in common?
  - ☐ A. They both are easy to make
  - ☒ B. They both conduct electricity
  - ☐ C. They both have a sour taste
  - ☐ D. They both have positively charged ions when dissolved in water

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**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).

**pH Scale**

Acidic	Neutral	Basic
[H <sub>3</sub> O <sup>+</sup> ] 10 <sup>0</sup> 10 <sup>-1</sup> 10 <sup>-2</sup> 10 <sup>-3</sup> 10 <sup>-4</sup> 10 <sup>-5</sup> 10 <sup>-6</sup> 10 <sup>-7</sup> 10 <sup>-8</sup> 10 <sup>-9</sup> 10 <sup>-10</sup> 10 <sup>-11</sup> 10 <sup>-12</sup> 10 <sup>-13</sup> 10 <sup>-14</sup>		
Lemon Juice (pH 2.2-2.4)	Milk (pH 6.4-6.6)	Household ammonia (pH 11.5)
Vinegar (pH 2.4-3.4)	Baking Soda (pH 8.4)	NaOH (1.0-14.0)
Stomach Acid (pH 1.0-2.0)	Blood (pH 7.4)	Milk of Magnesia (pH 10.5)
Seawater (pH 7.5-8.3)		
pH 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14		

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**ACIDS AND BASES**

ACIDIC				NEUTRAL		BASIC					
Strong				Weak	Neutral	Weak	Strong				
1	2	3	4	5	6	7	8	9	10	11	12
											

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.

Some common pH values

Substance	pH
Acid mine runoff	3.8 - 1.0
Battery acid	0.5
Gastric acid	2.0
Lemon juice	2.4
Cola	2.5
Vinegar	2.9
Orange or apple juice	3.5
Beer	4.5
Acid Rain	<5.0
Coffee	5.0
Tea	5.5
Milk	6.5
Pure water	7.0
Healthy human saliva	6.5 - 7.4
Blood	7.34 - 7.45
Sea water	8.0
Hand soap	9.0 - 10.0
Household ammonia	11.5
Bleach	12.5
Household lye	13.5

### 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 (**3.5-6.5**)

### Definitions to Know:

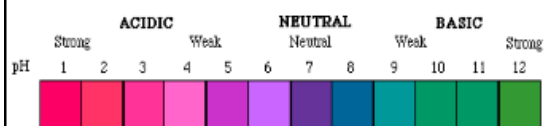
- WEAK BASE:** A base that only partially ionizes in an aqueous solution.
- That means not every molecule breaks apart.
- They usually have a pH close to 7 (**8.5-10.5**)

### Definitions to Know:

- NEUTRAL:** A solution which has a pH of 7.
- It is neither acidic nor basic.
- (the neutral range is: **6.5-8.5**)

### What is pH?

- Acids** have a pH less than 7
  - Strong acids: very low pH, 0-4
  - Weak acids: low pH, 3-6
- Bases** have a pH greater than 7
  - Strong bases: very high pH, 10-14
  - Weak bases: high pH, 8-10



### 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.

### Definitions to Know:

- **AQUEOUS:** A solution which is mainly water. Think about the word aquarium.
- **AQUA** means water.

### Definitions to Know:

- **STRONG ACID:** An acid which has a very low pH. (0-3.5)
- **STRONG BASE:** A base which has a very high pH. (10.5-14)

### 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).

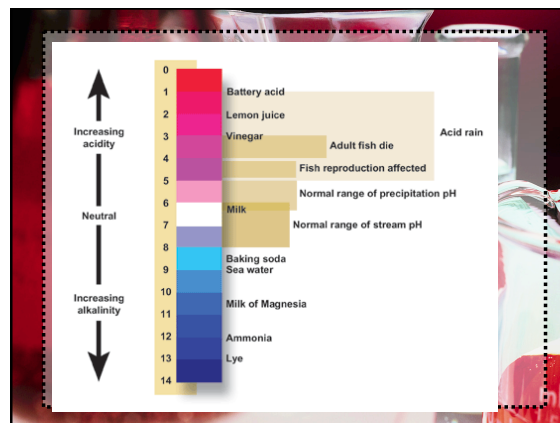
### ACIDS AND BASES



- 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.

Indicator	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Bromthymol Blue														
Litmus														
Methyl Orange														
Methyl Red														
Phenolphthalein														
Phenol Red														
Thymol Blue														

## Indicators: PLEASE WRITE THIS DOWN:

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

Indicator	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Bromthymol Blue														
Litmus														
Methyl Orange														
Methyl Red														
Phenolphthalein														
Phenol Red														
Thymol Blue														

## 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](#)



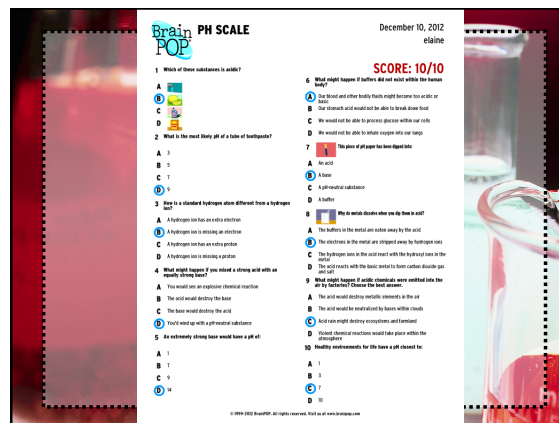
## Brain POP PH SCALE

December 10, 2012  
eSline

**SCORE: 10/10**

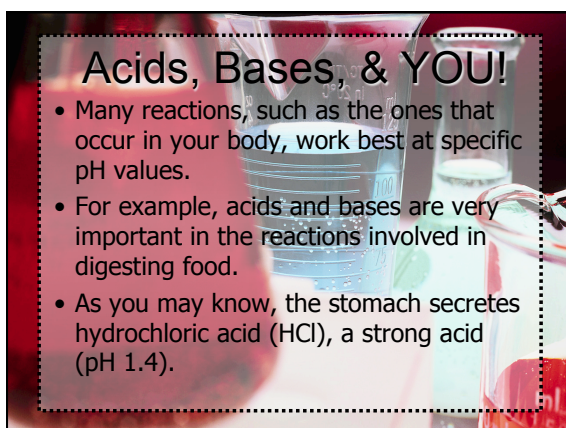
- Which of these substances is acidic?
  - A 1
  - B 2
  - C 3
  - D 4
- What is the most likely pH of a slice of lemon?
  - A 1
  - B 5
  - C 7
  - D 9
- How is a standard hydrogen atom different from a hydrogen ion?
  - A A hydrogen ion has an extra electron.
  - B A hydrogen ion is missing an electron.
  - C A hydrogen ion has an extra proton.
  - D A hydrogen ion is missing a neutron.
- 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 end up with a pH-neutral substance.
- An extremely strong base would have a pH of:
  - A 1
  - B 7
  - C 9
  - D 10
- 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 properly process within our cells.
  - D We would not be able to release oxygen into our lungs.
- The pH of a pH paper has been dipped into:
  - A An acid
  - B A base
  - C A pH-neutral substance
  - D A buffer
- Why is water neutral when you dip blue litmus?
  - A The buffers in the water 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 water.
  - D The acid reacts with the base metal to form carbon dioxide gas.
- What might happen if acidic compounds were not released into the air by volcanoes? 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 Strong chemical reactions would take place within the atmosphere.
- Healthy environments for life have a pH closest to:
  - A 1
  - B 5
  - C 7
  - D 10

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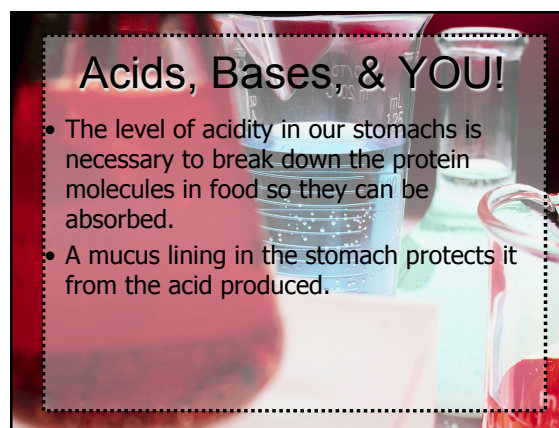
## Acids, Bases, & YOU!

- 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).



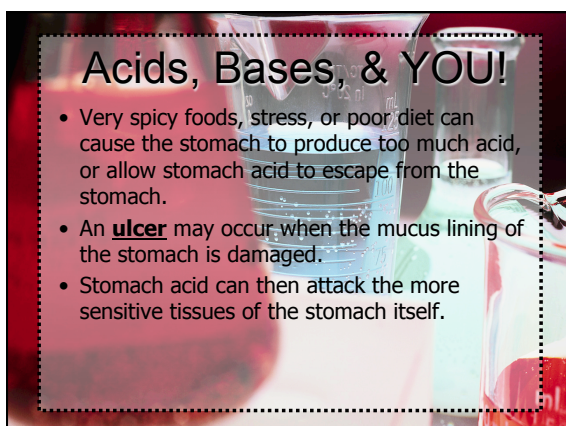
## Acids, Bases, & YOU!

- 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.



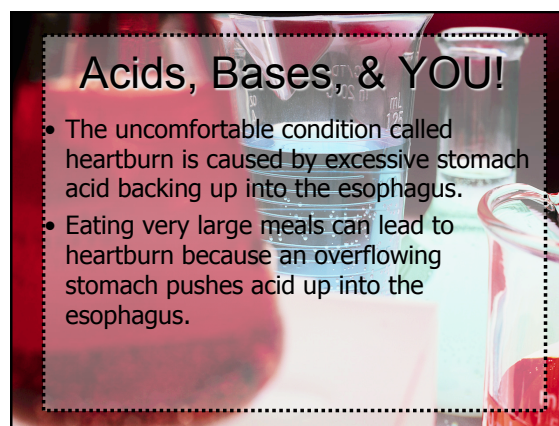
## Acids, Bases, & YOU!

- 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.

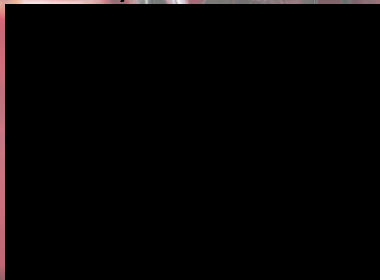


## Acids, Bases, & YOU!

- 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.

