Chemistry

Monday, April 23rd – Tuesday, April 24th, 2018

Do-Now: "**Ch. 16 CN Part A**"

1. Write down today's FLT
2. Spontaneity of a rxn is determined by ___ and ____.
3. The universe tends towards ____ enthalpy and _____ entropy.
4. What is Gibbs Free Energy?
5. What is the equation for Gibbs Free Energy?
6. ΔG is always spontaneous (or -) when _____ and _____.
7. Take out your planner and ToC

FLT

- I will be able to describe the properties of acids and bases of a reaction by completing Ch. 16 Notes Part A

Standard

HS-PS1-1: Properties of Elements

HS-ESS2-5: Properties of Water

HS-ESS3-4: Human Impacts

Ch. 16: Acid-Base Theories

Introduction

Introduction

- **Ions to know:**
  - **OH^- = Hydroxide Ion**
  - **H^+ = Hydrogen Ion = proton**
  - **H_3O^+ = Hydronium Ion**
- H_3O^+ and H^+ are often used interchangeably in water because $H_2O + H^+ \leftrightarrow H_3O^+$

Acids and Bases

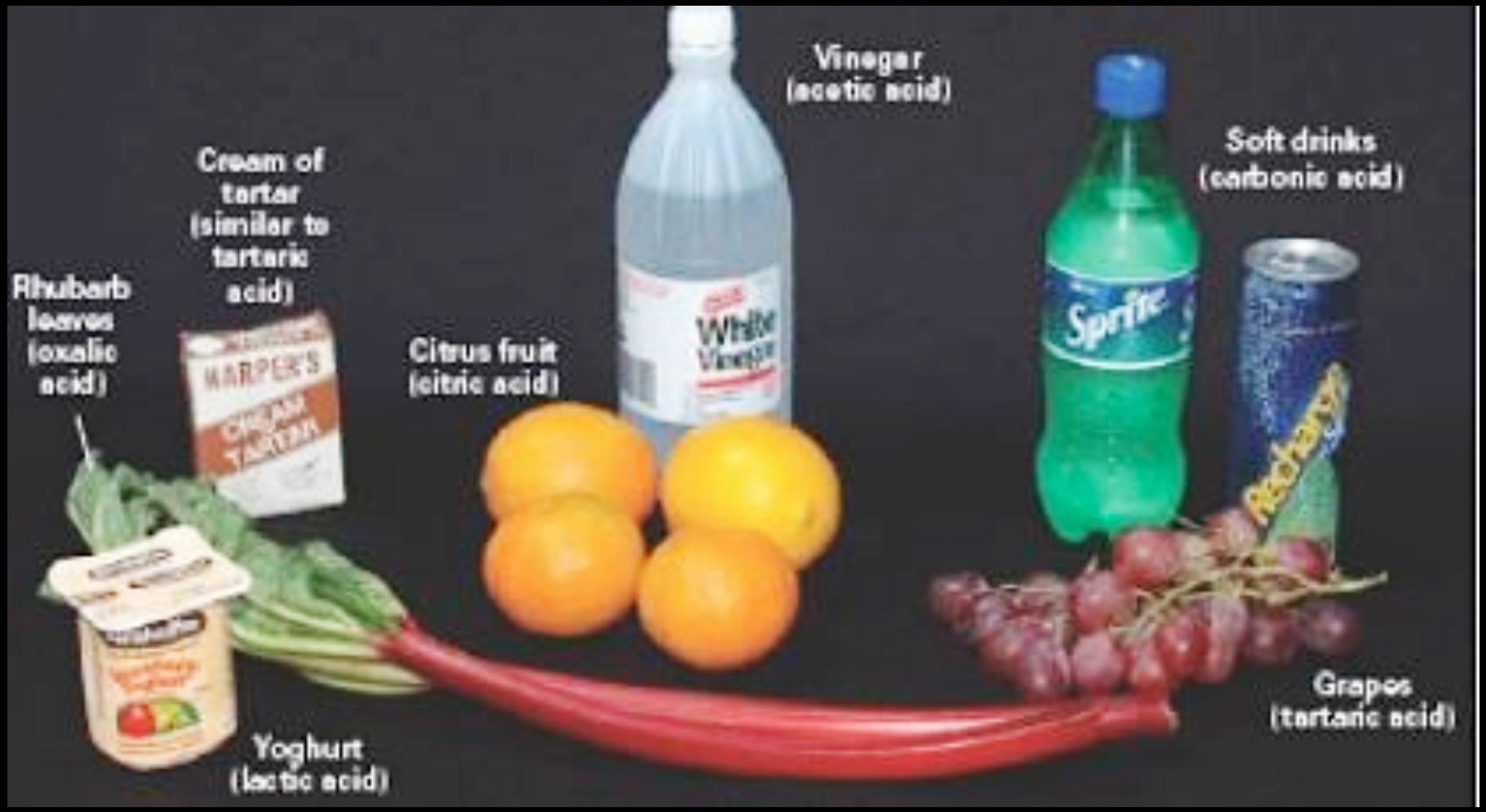
Acids and Bases

- What is an acid?
- What is a base?
  - Both are necessary for life
  - Can be found in common substances, from sodas to soaps

Acids

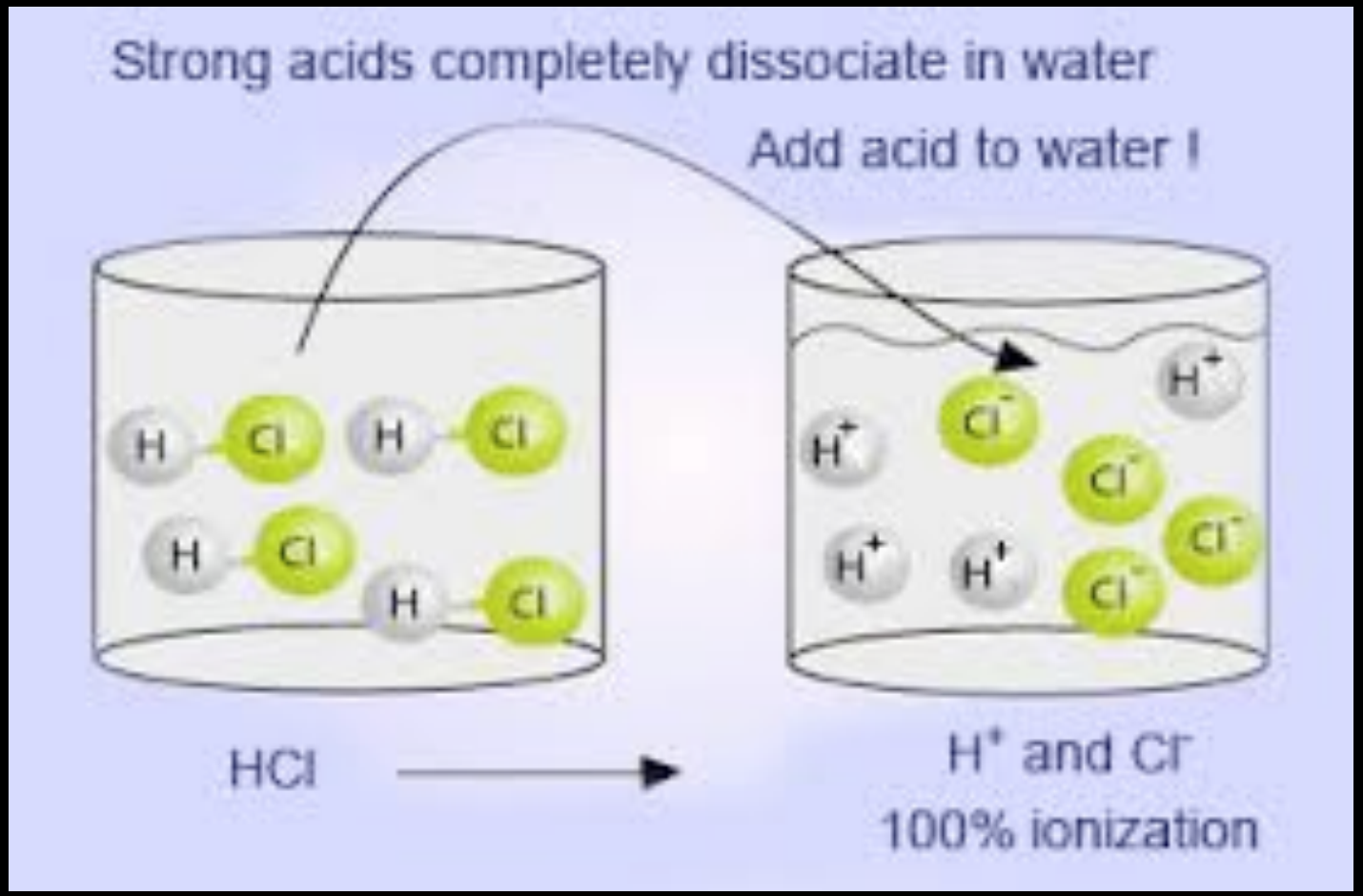
Acids

- "Acid" → Latin word acidus, for *sour*



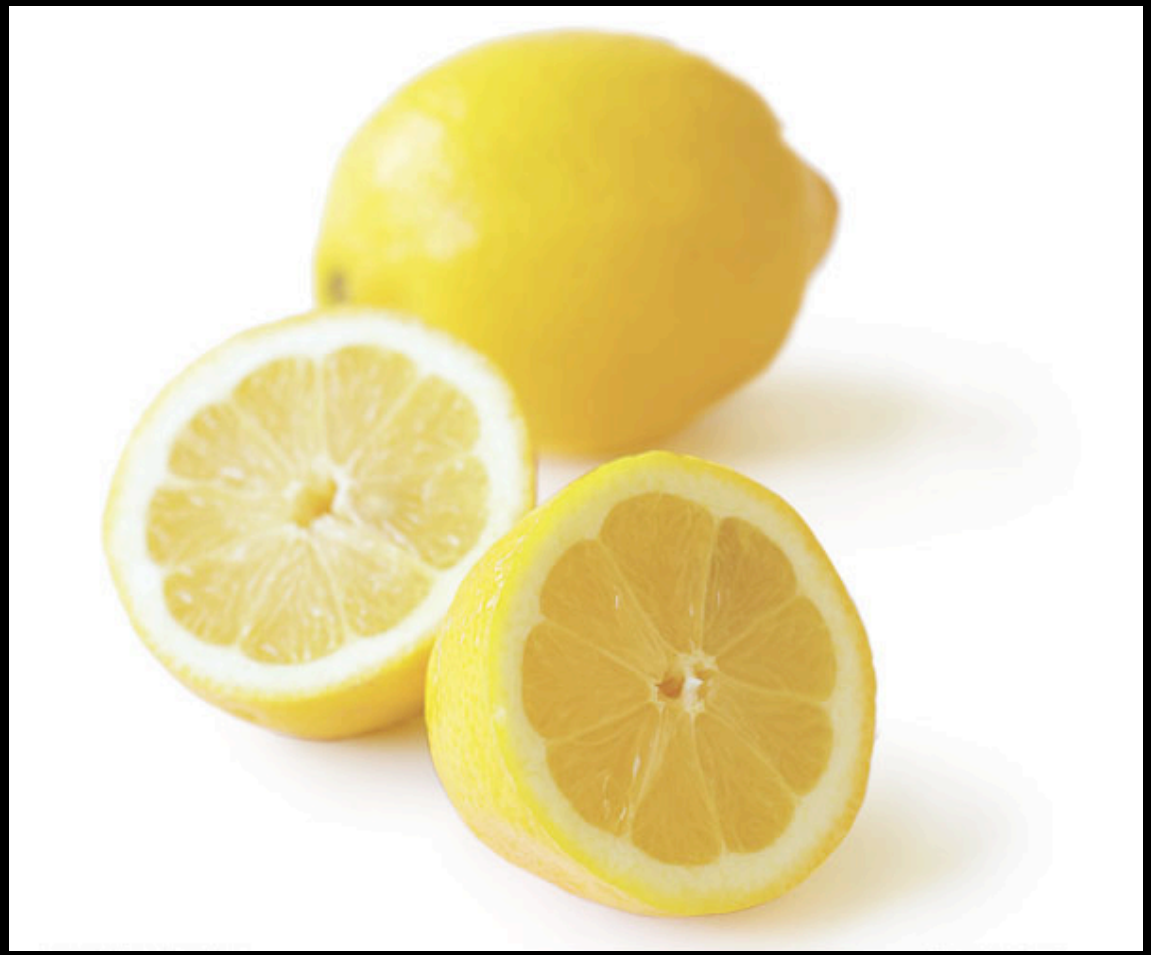
Acids

- **Acids = Increase [H^+] in water**



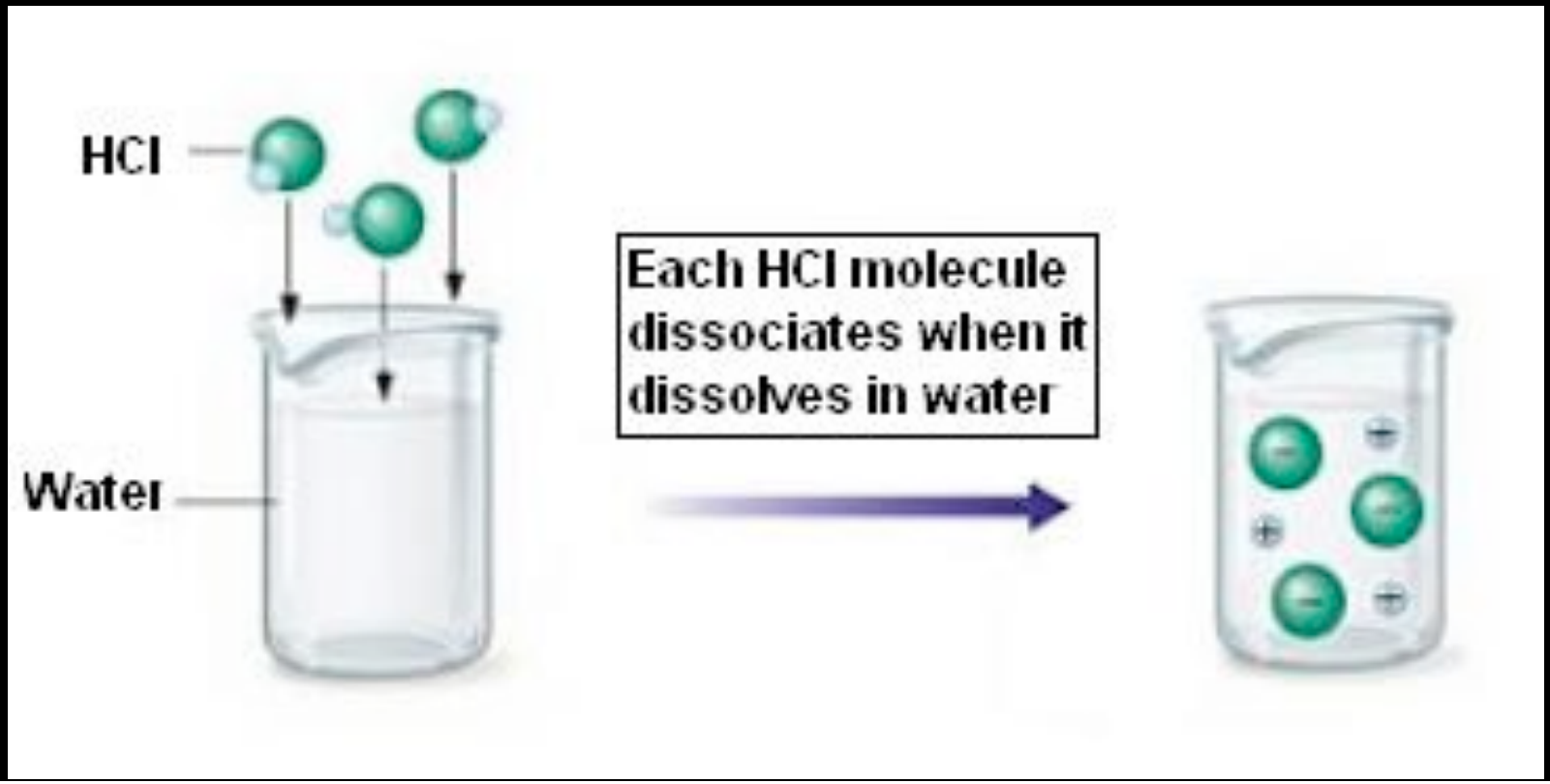
Acids

- **Properties of Acids:**
  - Taste **sour**



Acids

- Properties of Acids:
  - **Electrolytes (conduct electricity)**
  - May be a strong or weak electrolyte, depending on the acid



Acids

- Properties of Acids:
  - **<u>React w/ metals to form H_2 gas</u>**

$$HCl_{(aq)} + Mg_{(s)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$$

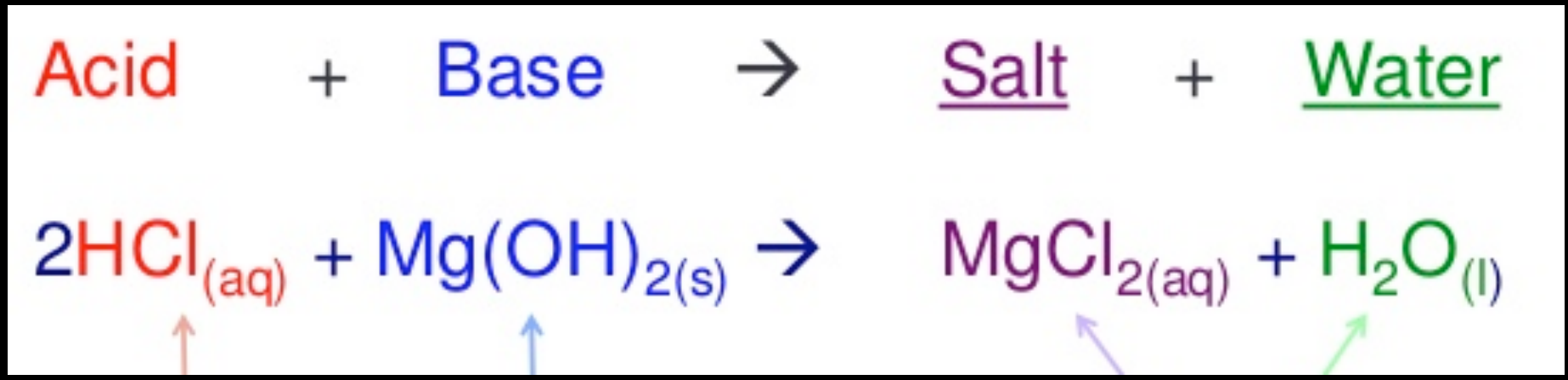
Acids

- Properties of Acids:
  - **Changes the color of indicators**
    - Ex/ Blue litmus turns red

Blue litmus paper turning red in an acid.

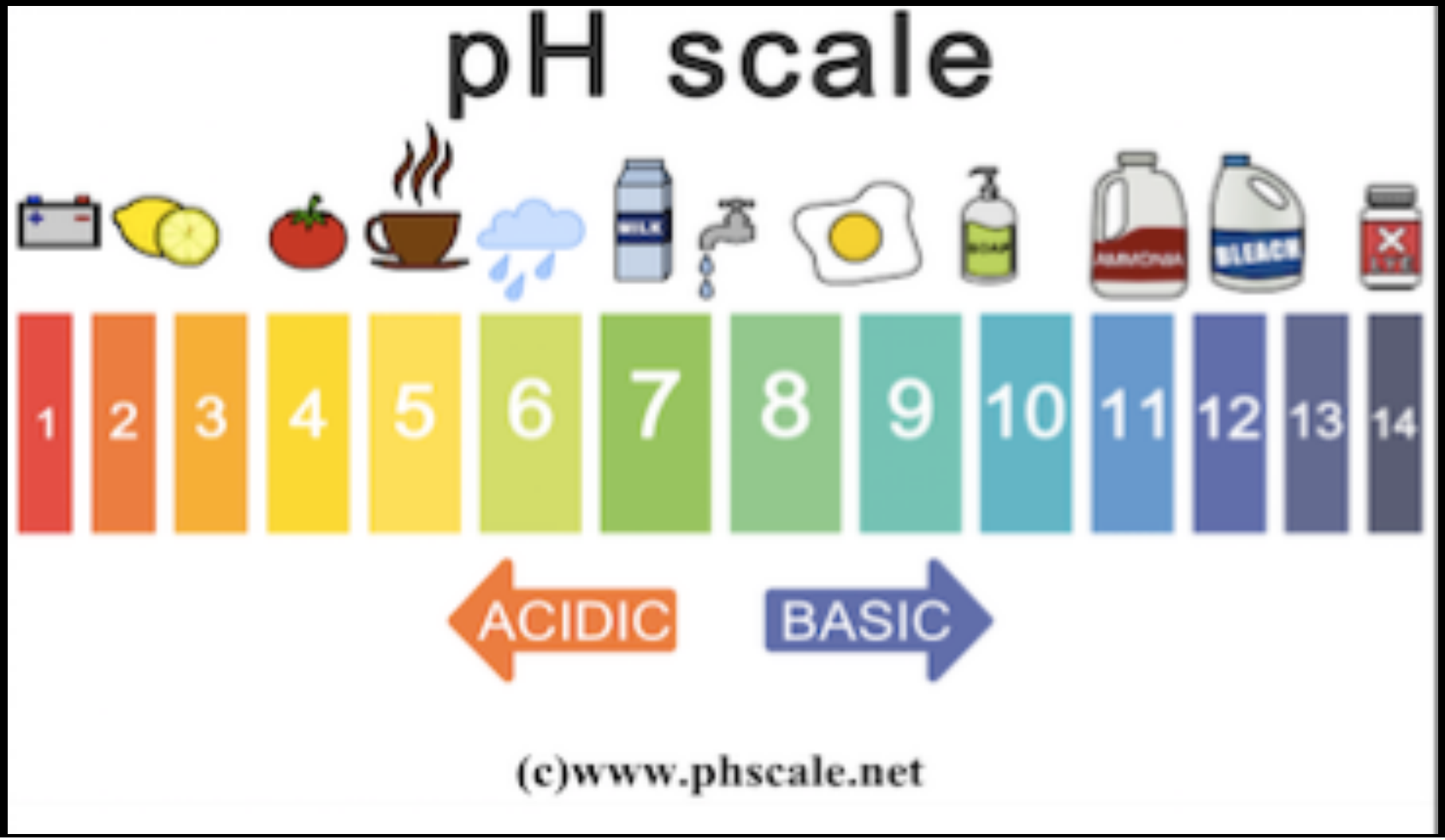
Acids

- Properties of Acids:
  - **Neutralization: react w/ bases to form H_2O + a salt**



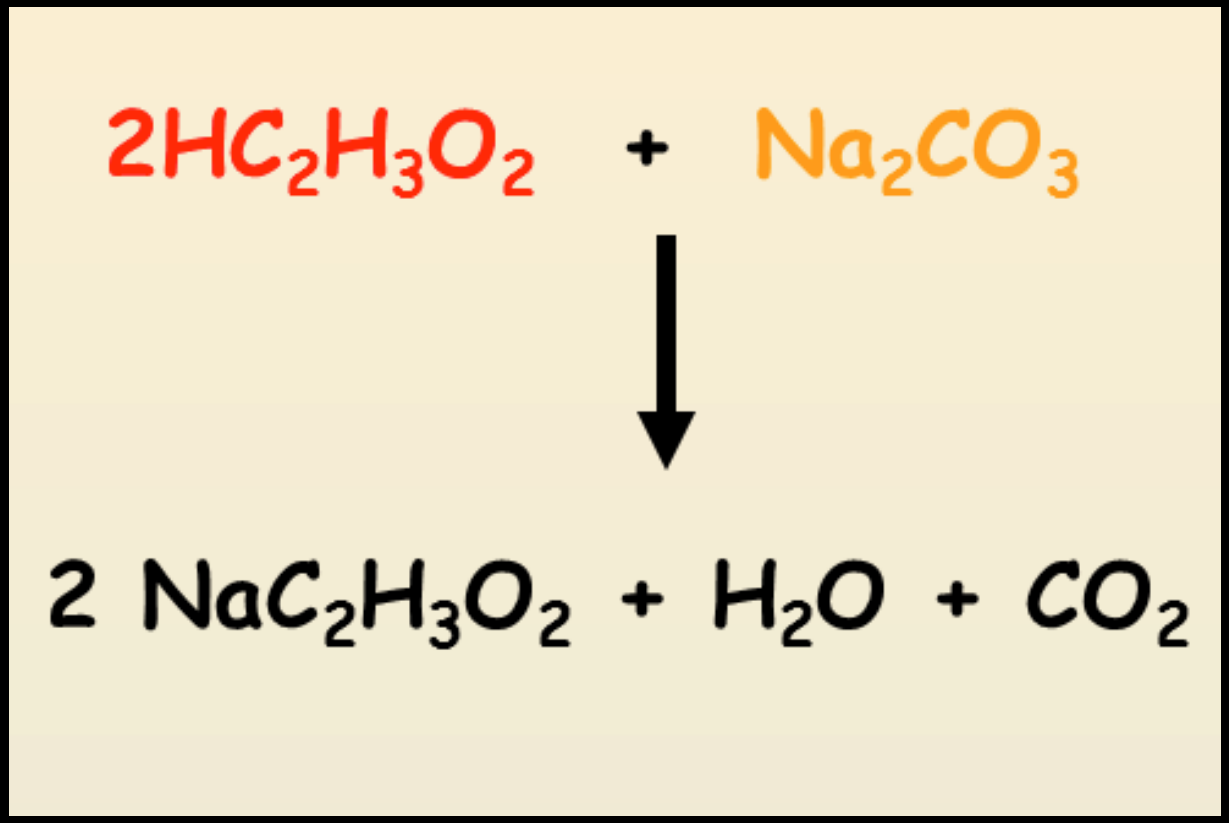
Acids

- Properties of Acids:
  - Have a **pH < 7**



Acids

- Properties of Acids:
  - React with carbonates and bicarbonates to produce a salt, water, and carbon dioxide gas



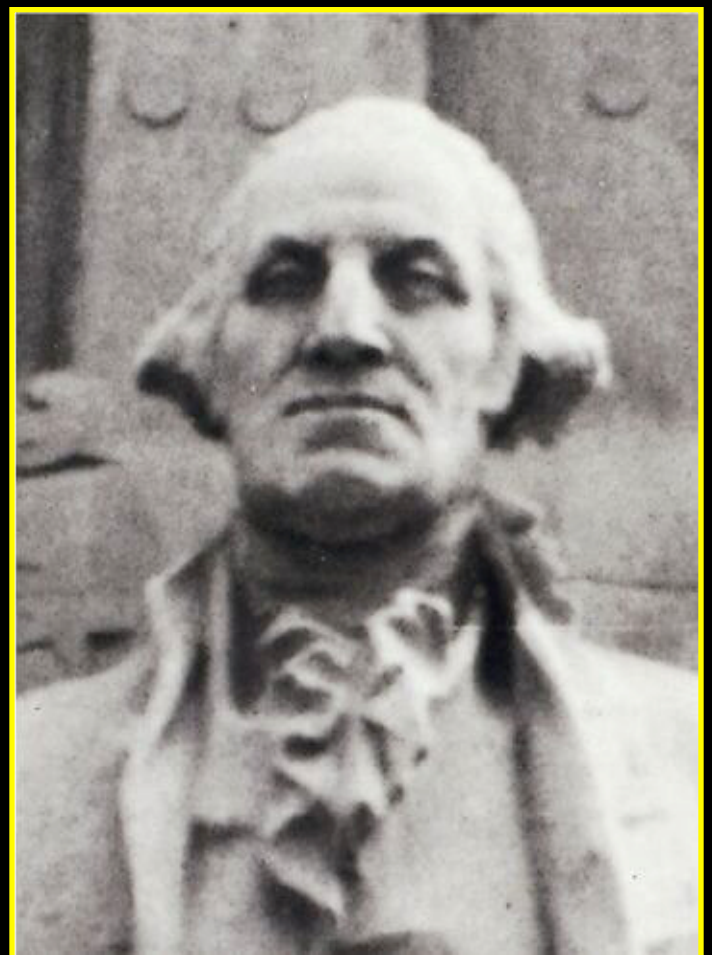
Acids

- How do you know if a chemical is an acid?
  - Usually (not always) starts with hydrogen
  - **Examples of acids:**
  - **HCl (monoprotic)**
  - **H_2SO_4 (diprotic)**
  - **H_3PO_4 (triprotic)**

Effects of *Acid Rain* on Marble

(marble is calcium carbonate)

George Washington: BEFORE acid rain



George Washington: AFTER acid rain

Acids *Neutralize* Bases

$HCl + NaOH \rightarrow NaCl + H_2O$

-Neutralization reactions ALWAYS produce a salt (which is an *ionic compound*) and water.

-Of course, it takes the *right proportion* of acid and base to produce a neutral salt

Pair-Share-Respond

1. **Describe four properties of acids**
2. **What does a neutralization reaction always produce?**
3. **Distinguish between the terms monoprotic and diprotic**
4. **What are two names for H^+?**

Naming Acids

Naming Acids

- **Binary Acids** (hydrogen + another element)
- Named as **hydro_____ic acid**
- **Ex/**
- **HF = hydro*fluor*ic acid**
- **H_2S = hydrosulfuric acid**
- What would be the names of…
  - HBr?
  - H_3P?
  - HCl?

Naming Acids

- **Oxyacids** (contain a polyatomic ion)
- IF the polyatomic ion **ends in –ate**, then..
- **_____ic acid** (no hydro)
- **Ex/**
- **HNO_3 = *nitric* acid**
- **H_2SO_4 = sulfuric acid**
- What would be the names of…
  - H_2CO_3?
  - H_3PO_4?

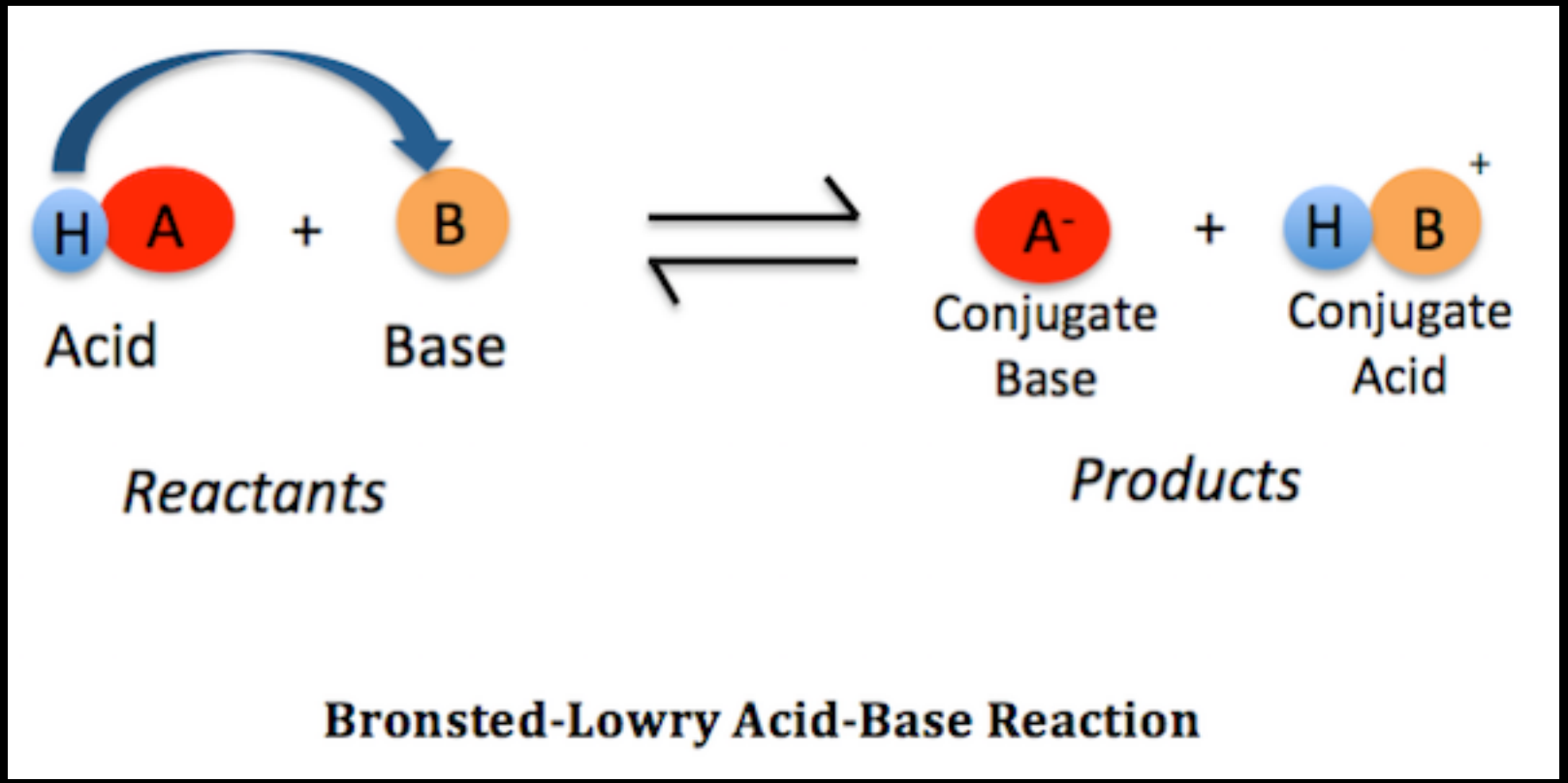
Bases

Bases

- "Alkali" → Arabic for the ashes that come from burning certain plants

Bases

- **Bases = increases [OH^-] in water**

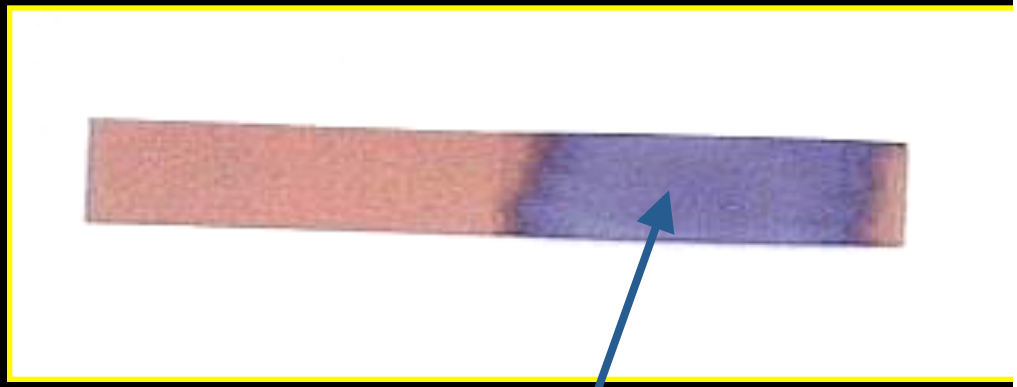


Bases

- **Properties of Bases:**
  - Taste **bitter** and feel **slippery**

Bases

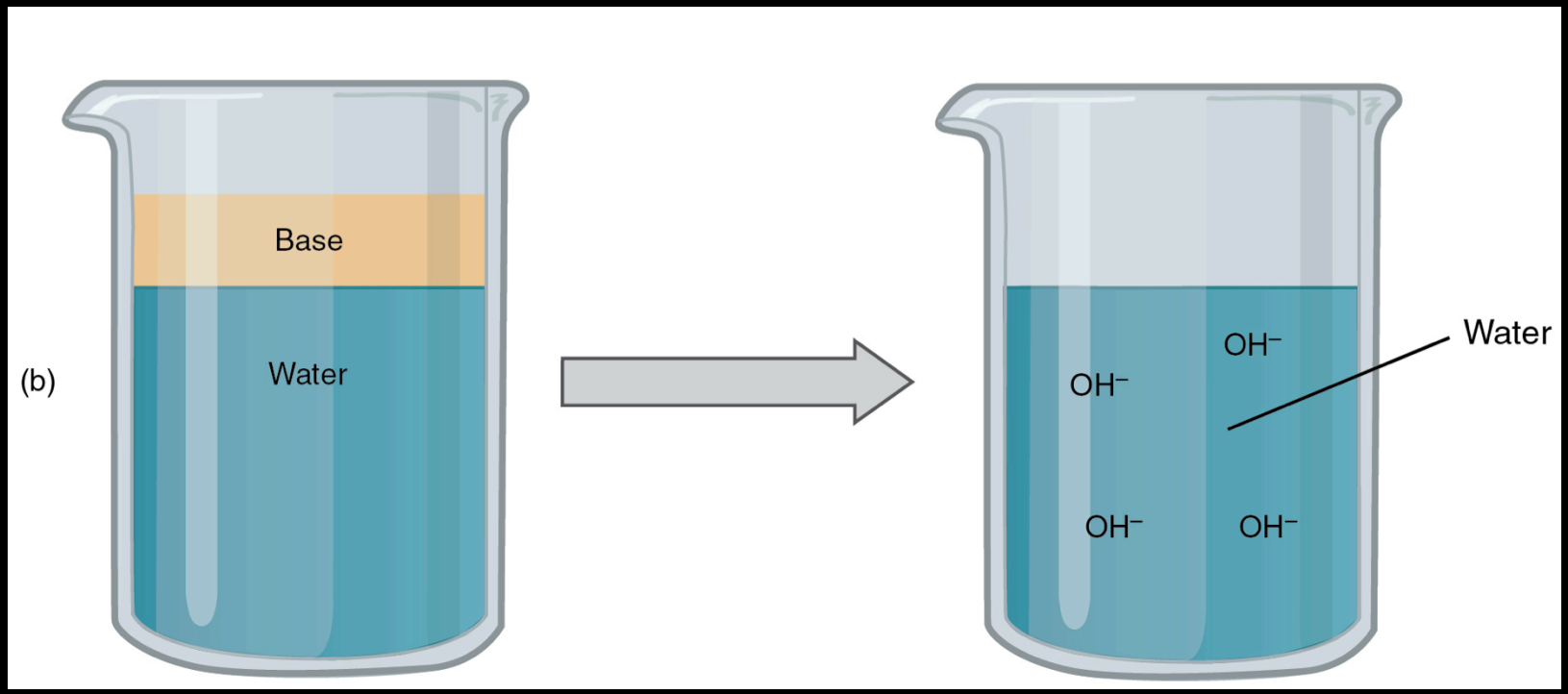
- Properties of Bases:
  - **Change the color of indicators**
  - Ex/Red litmus turns blue



Red litmus paper turns blue in contact with a base (and blue paper stays blue).

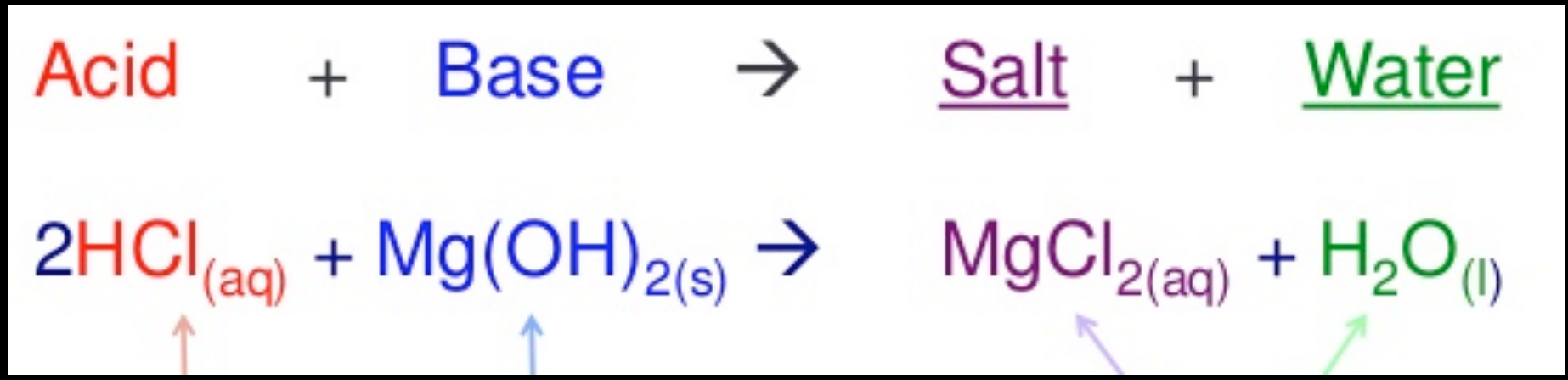
Bases

- Properties of Bases:
  - May be a strong or weak **electrolyte** in solution



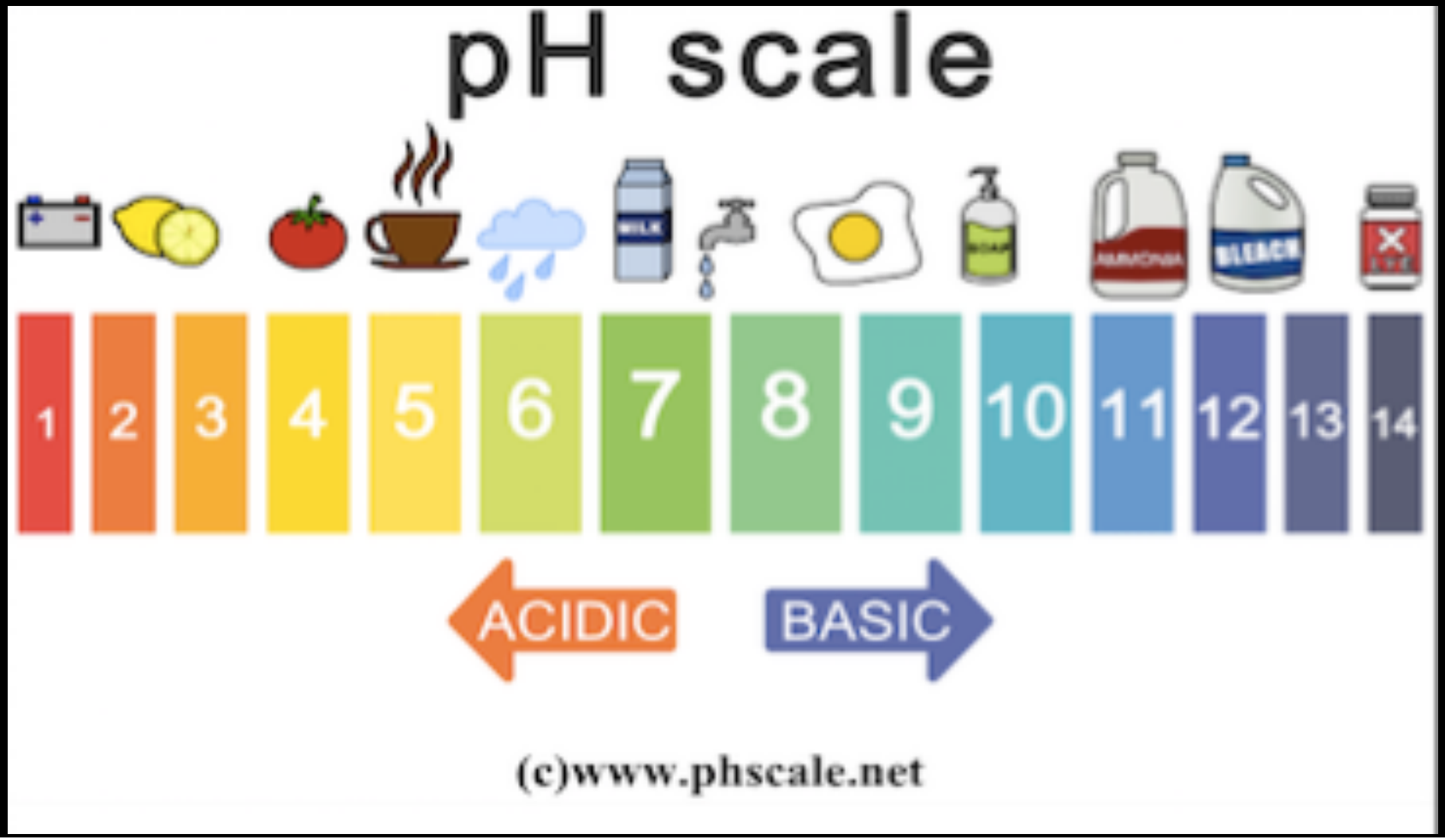
Bases

- Properties of Bases:
  - **Neutralization** - react with acids to form water and a salt



Bases

- Properties of Bases:
  - Have a **pH > 7**



Bases

- How do you know if a chemical is a base?
  - Usually (not always) ends with OH^-
  - **Examples of bases:**
  - **NaOH**
  - **$Ca(OH)_2$**
  - **NH_3**

Bases Neutralize Acids

Milk of Magnesia contains magnesium hydroxide, $Mg(OH)_2$, which neutralizes stomach acid, HCl.

$$2\ HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2\ H_2O$$

Magnesium salts can cause diarrhea (thus they are used as a laxative) and may also cause kidney stones.

Three Definitions of Acids-Bases (Three Theories)

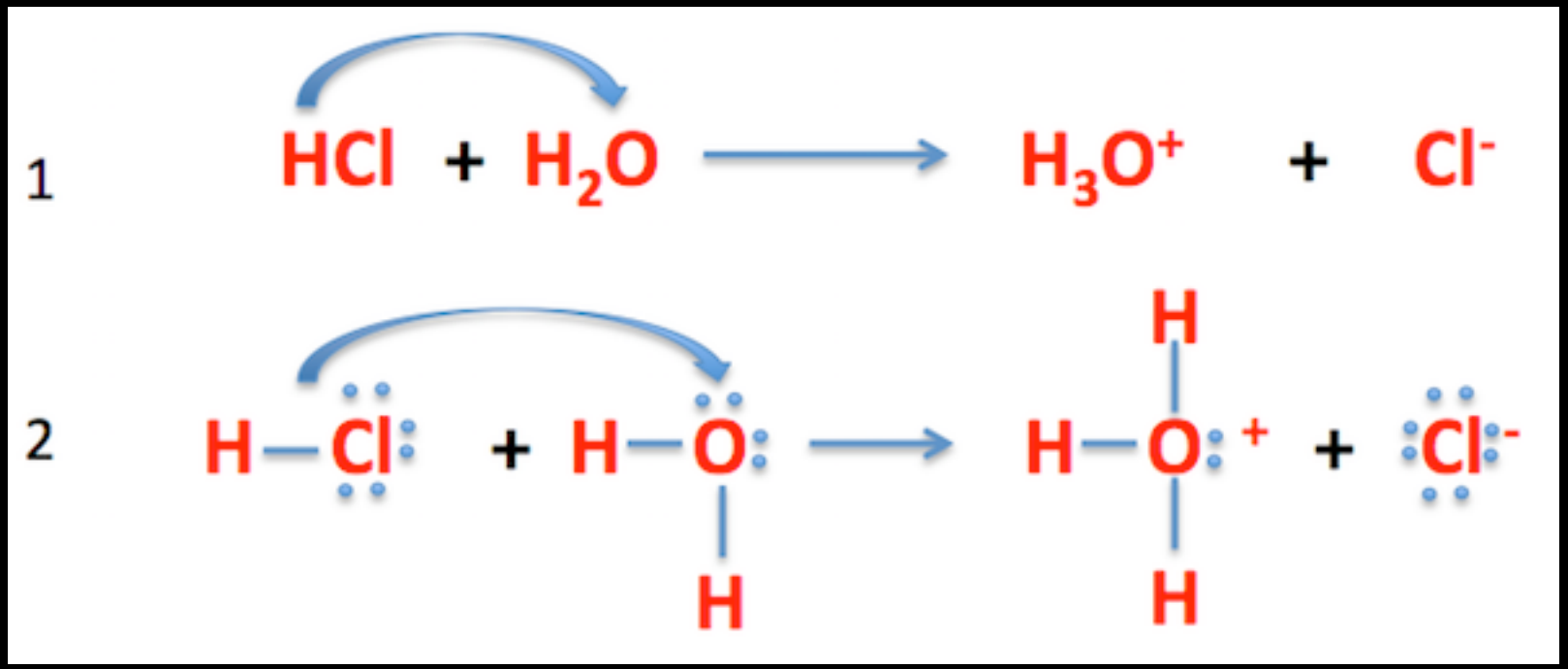
Three Acid-Base Theories

- Arrhenius
- Brønsted-Lowry
- Lewis

Arrhenius Acid-Base Theory

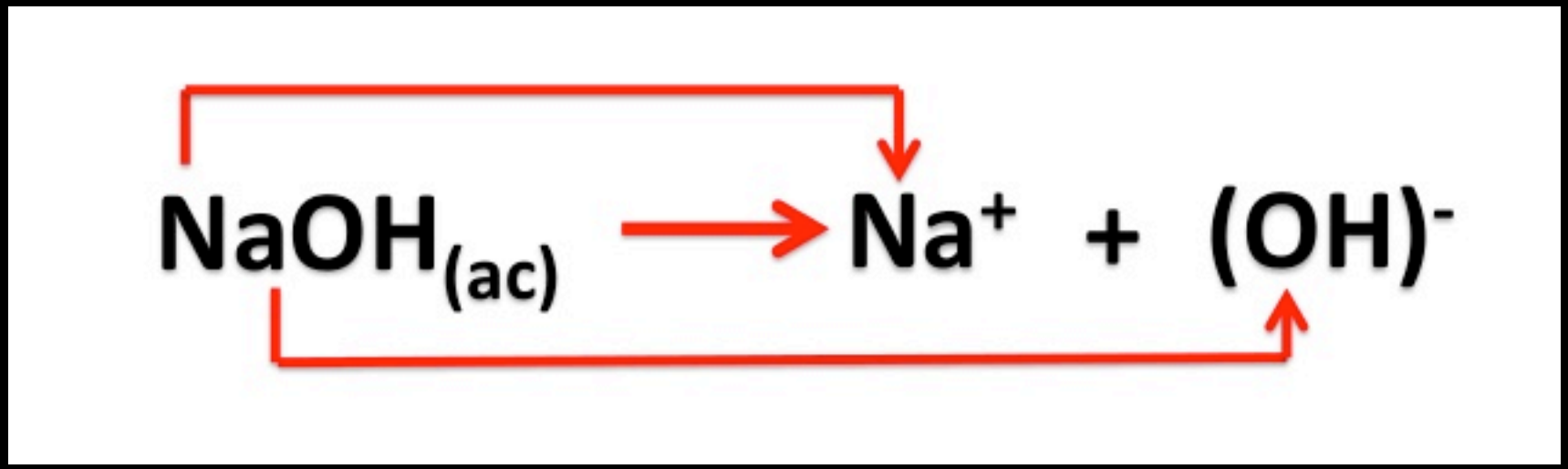
Arrhenius Acid-Base Theory

- **Arrhenius Acid = Donates H^+ in water**
- **Arrhenius Base = Donates OH^- in water**
- (Increases the concentration of ions in water)



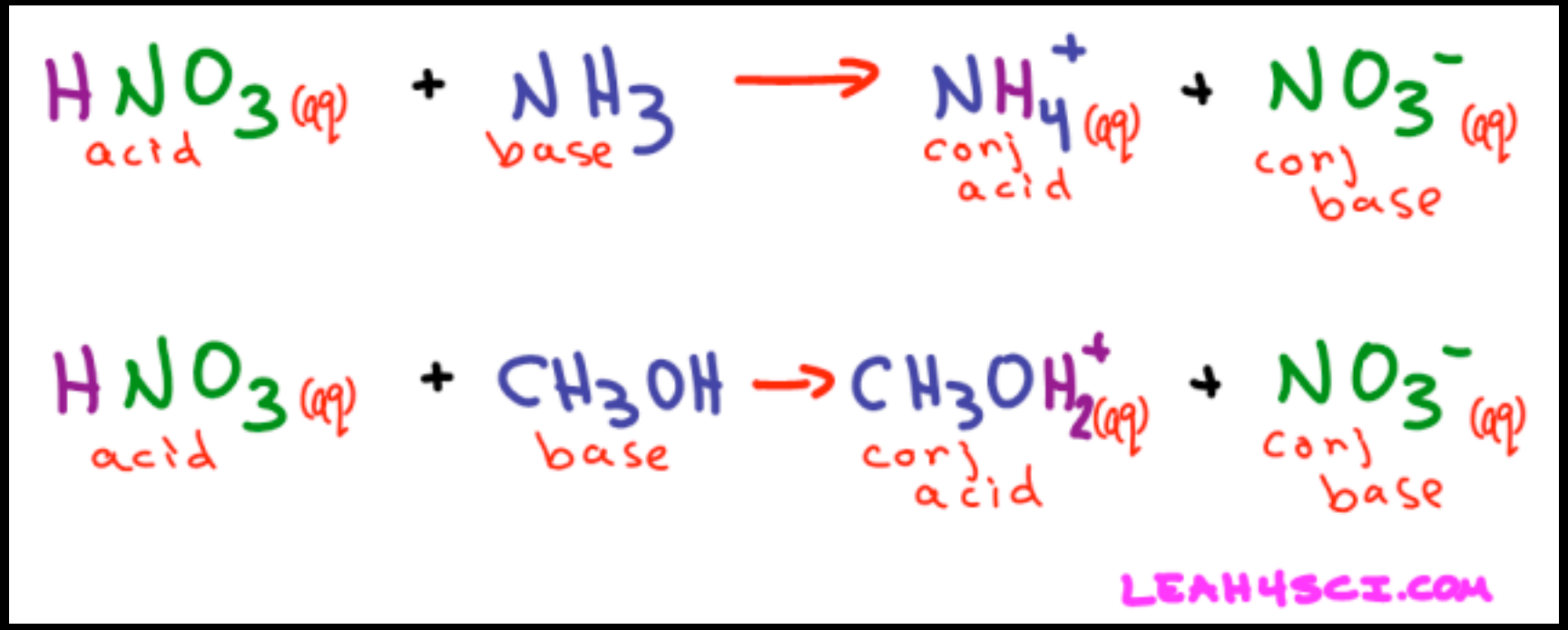
Arrhenius Acid-Base Theory

- **Arrhenius Acid = Donates H^+ in water**
- **Arrhenius Base = Donates OH^- in water**



Arrhenius Acid-Base Theory

- What about substances that still are acidic/ basic, but don't do this?



Brønsted-Lowry Acid-Base Theory

Brønsted-Lowry Acid-Base Theory

- **Brønsted-Lowry Acid: Donates a proton (H^+)**
  Brønsted-Lowry Base: Accepts a proton (H^+)

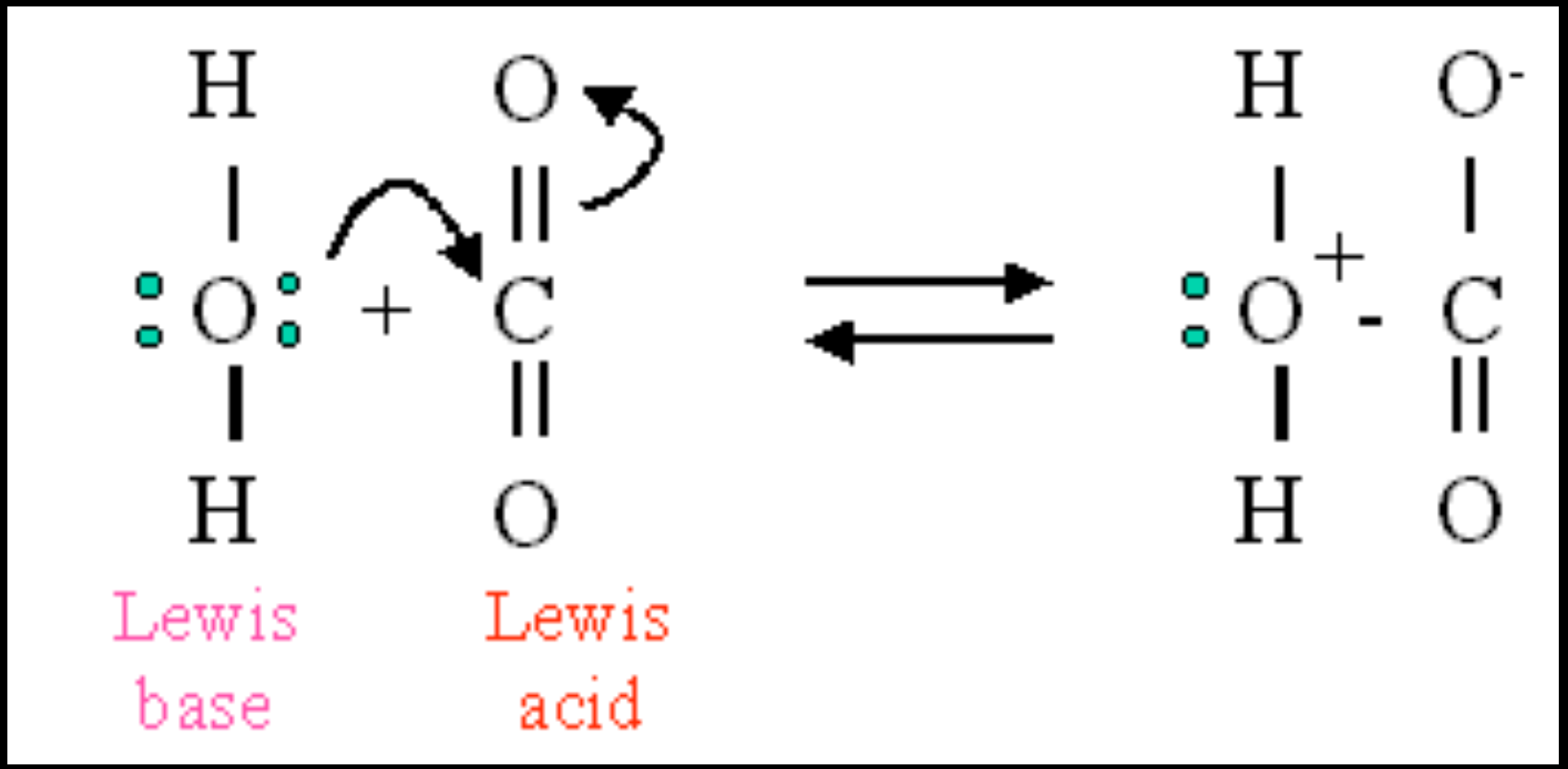
Brønsted-Lowry Acid-Base Theory

- Typically the most accepted theory

Lewis Acid-Base Theory

Lewis Acid-Base Theory

- **Lewis Acid = Accepts an e^- pair**
- **Lewis Base = Donates an e^- pair**



Lewis Acid-Base Theory

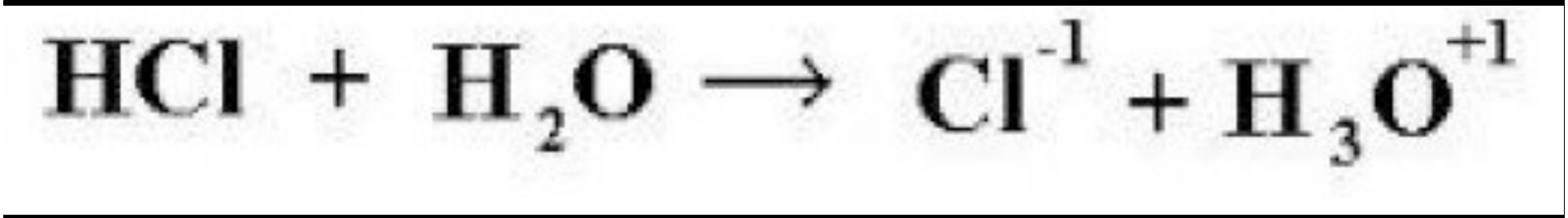
- Useful with organic chemistry

Sample Problems

- Which is the acid? Base?

Sample Problems

- Which is the acid? Base?



Sample Problems

- *What will form when the following donate (or lose) a proton?*
- **HCl**
- **H_2O**
- **HNO_3**
- **H_2SO_4**

Sample Problems

- *What will form when the following accept (or gain) a proton?*
- **Br^-**
- **H_2O**
- **NO_3^-**
- **SO_3^{2-}**

Pair-Share-Respond

1. **What is the name of HCl?**
2. **What is the name of $HClO_3$?**
3. **Describe three properties of bases**
4. **List three acid-base theories**
5. **Distinguish between an Arrhenius base and a Brønsted-Lowry Base**

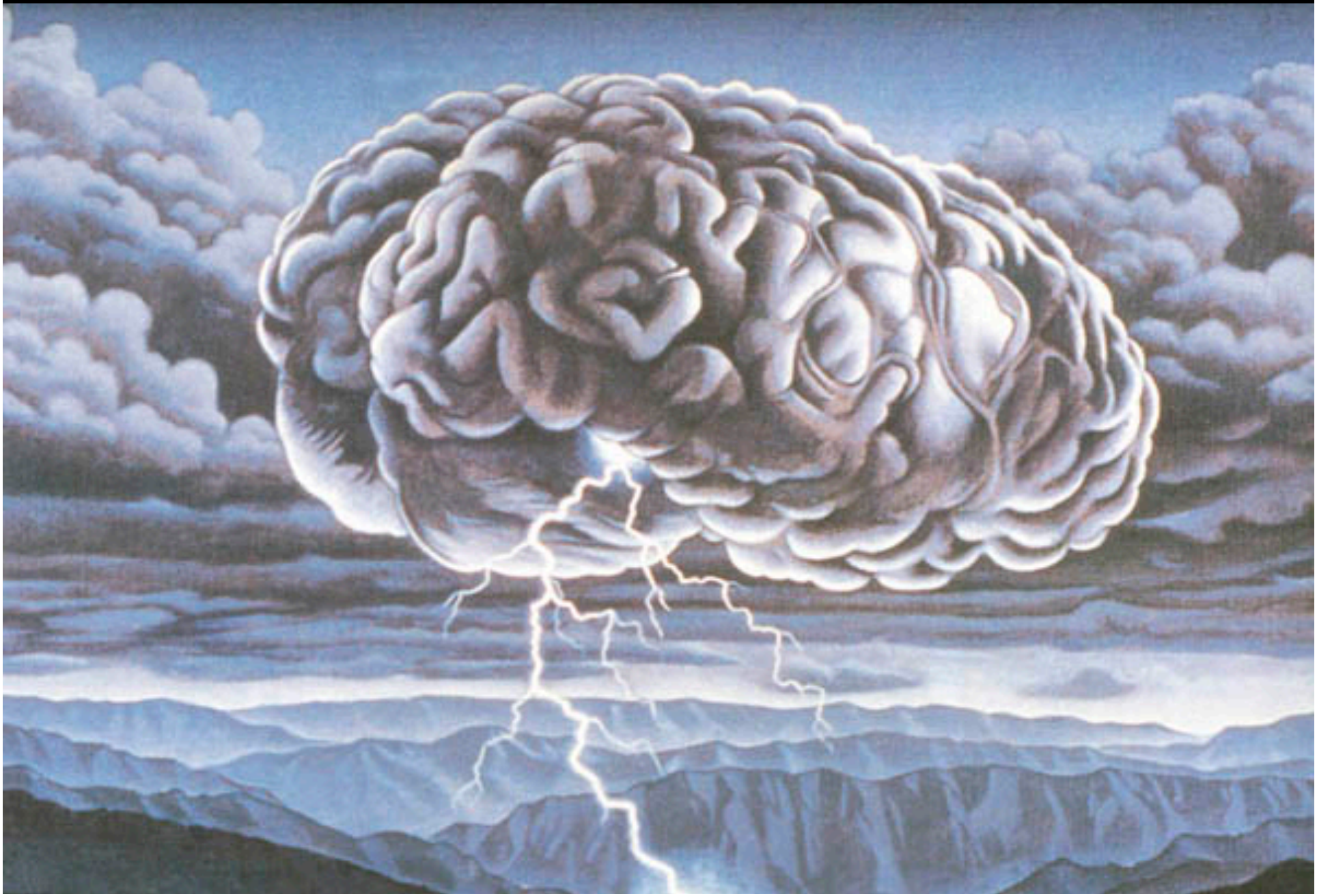
Chemistry

Wednesday, April 25th – Thursday, April 26th, 2018

Do-Now: "**Ch. 16 CN Part B**"

1. Write down today's FLT
2. List two properties of acids.
3. List two properties of bases.
4. How do the definitions of Arrhenius acid-bases differ from Brønsted-Lowry definitions?
5. Copy the equation: $HBr + H_2O \rightarrow Br^- + H_3O^+$
6. Draw arrows between your reactants and products to determine which molecule is your acid, and which is your base.
7. Take out your planner and ToC

Brainstorm Protocol



FLT

- I will be able to calculate the pH and pOH of a solution given concentrations by completing Ch. 16 CN Part B

Standard

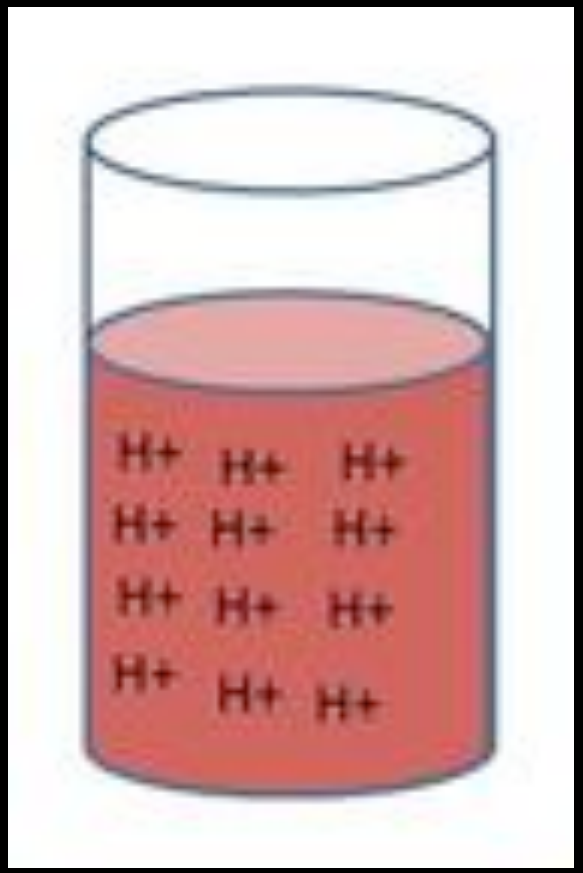
HS-PS3-1: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known

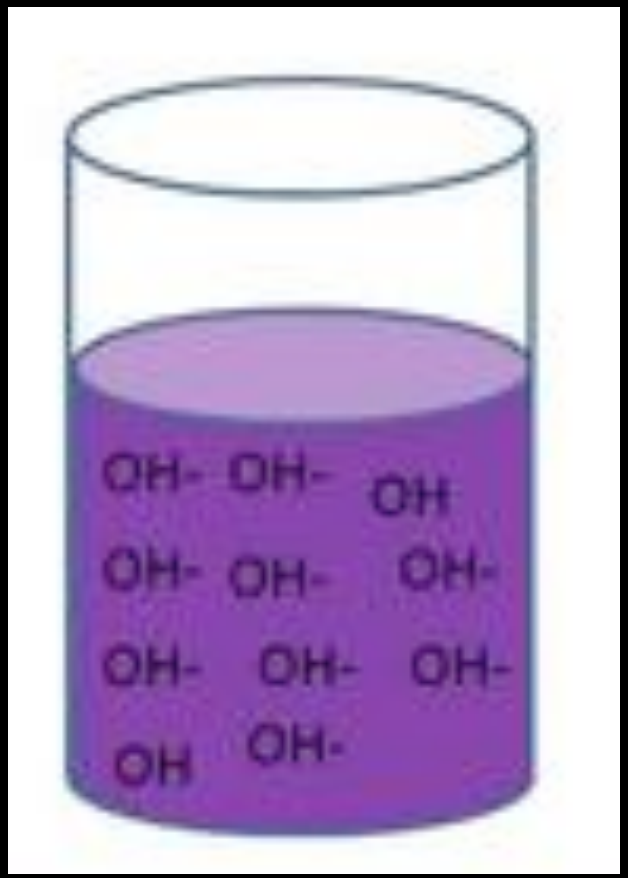
Ch. 16: The pH Scale

Recall

Recall

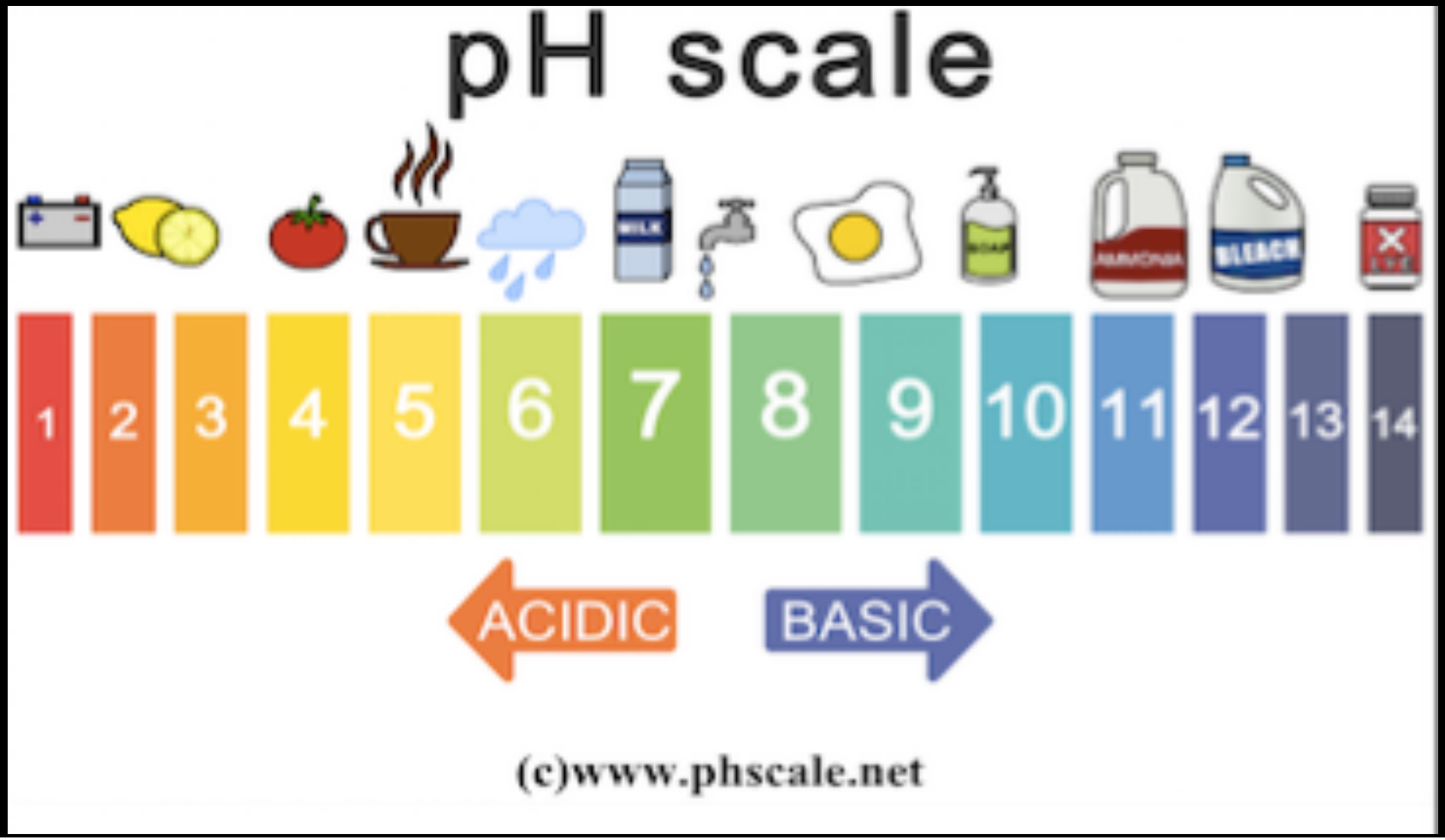
- Acids increase [H^+] in water
- Bases increase [OH^-] in water





Recall

- Acids have a LOW pH
- Bases have a HIGH pH



The pH Scale

The pH Scale

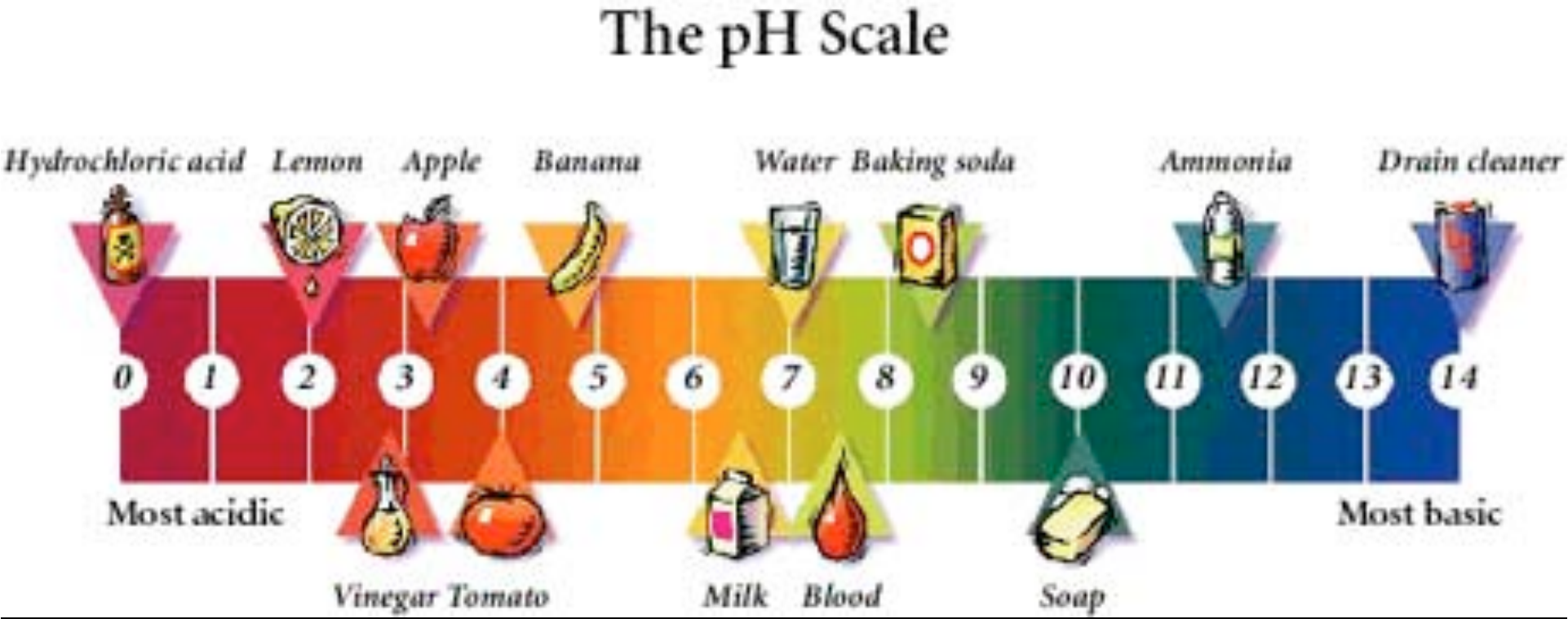
- pH is a measure of how acidic or basic a solution is
- **pH = measurement of [H^+]**
- pH → potential of Hydrogen

The pH Scale

- pH can be approximated using indicators (such as litmus paper) or measured accurately using a pH meter.

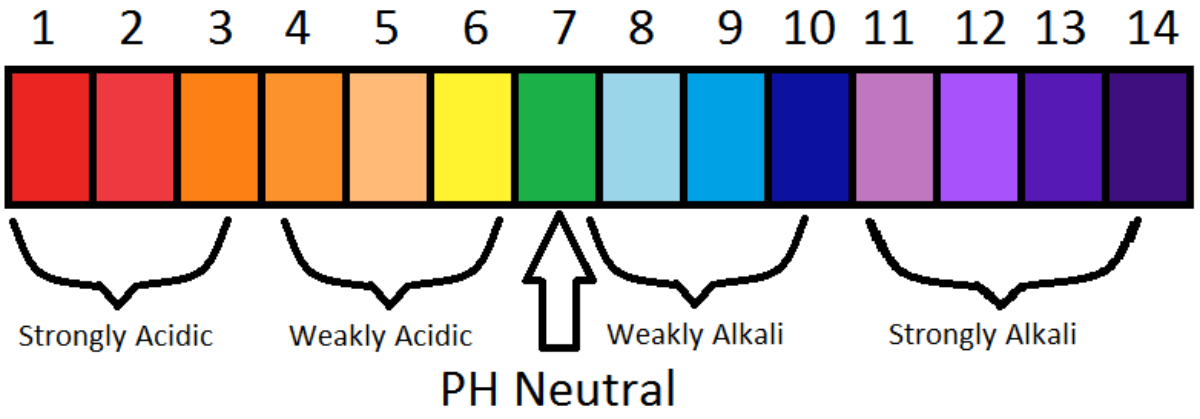
The pH Scale

- **The pH scale ranges from 0 to 14**



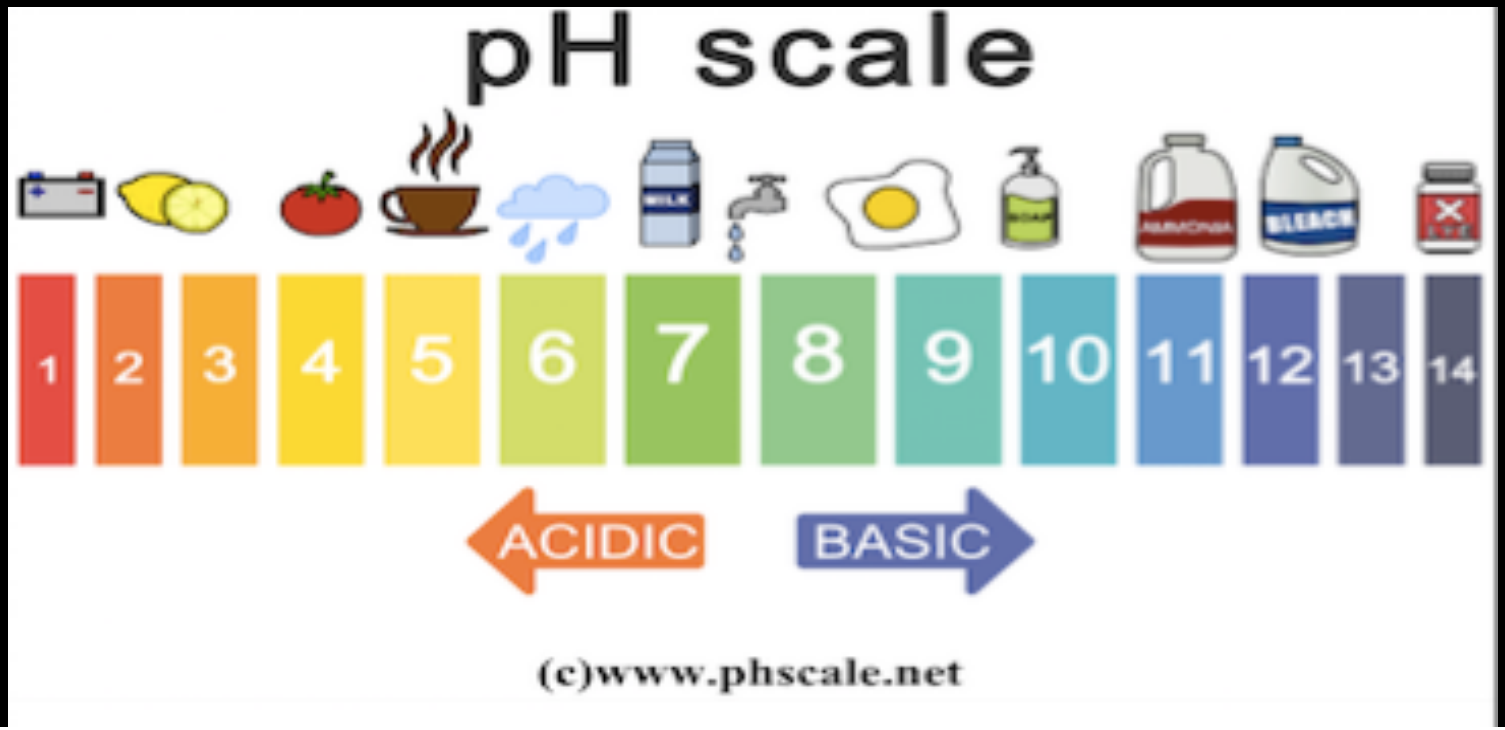
The pH Scale

- **A soln' with a pH =7 is neutral**
- Pure water is neutral
- Is tap water neutral?



The pH Scale

- **A soln' with a pH < 7 is acidic**
- pH of orange juice is ~ 3.3
- pH of lemon juice is ~2
- Which is more acidic?

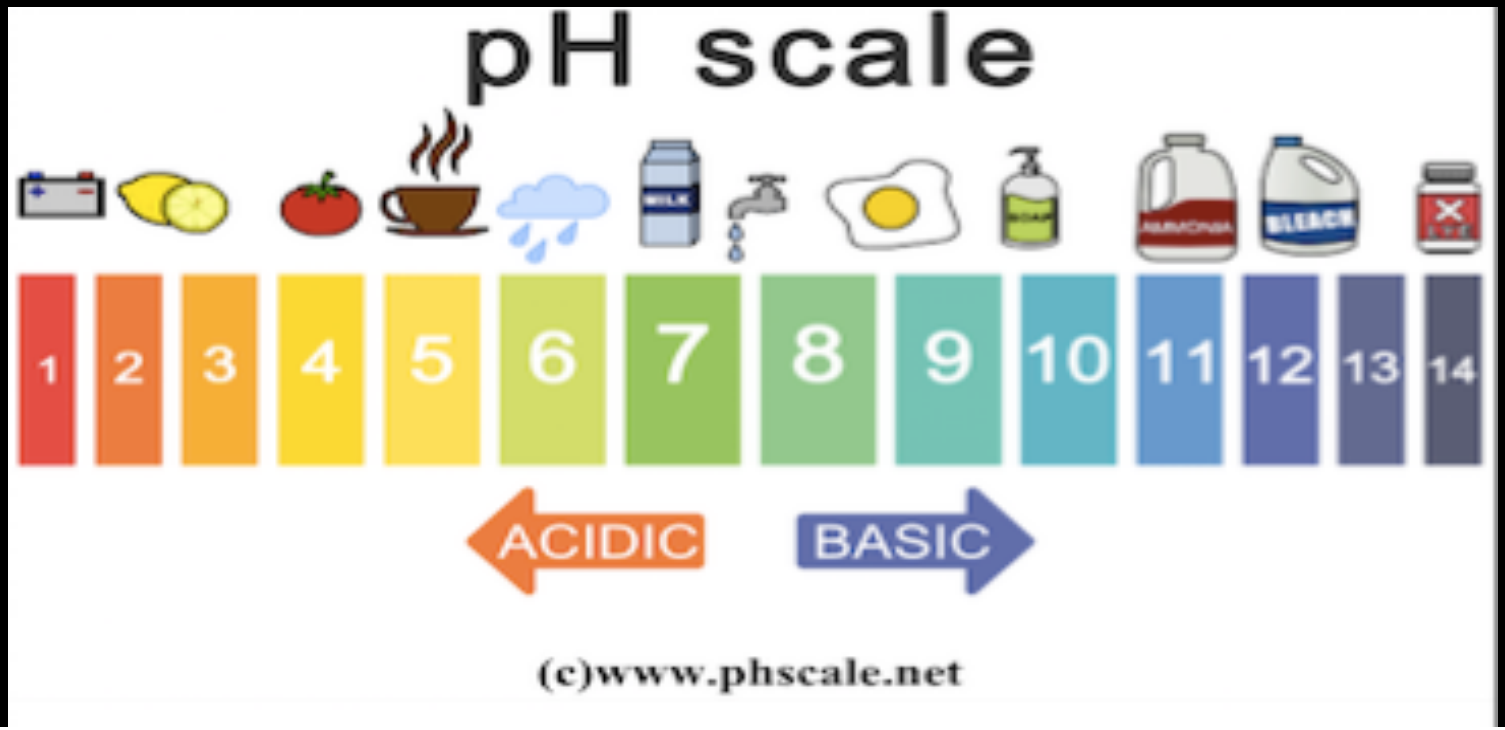


The pH Scale

- **The lower the pH, the more acidic the soln' is**

The pH Scale

- **A soln' with a pH > 7 is basic**
- pH of baking soda solution ~8.4
- pH of toothpaste ~10
- Which is more basic?



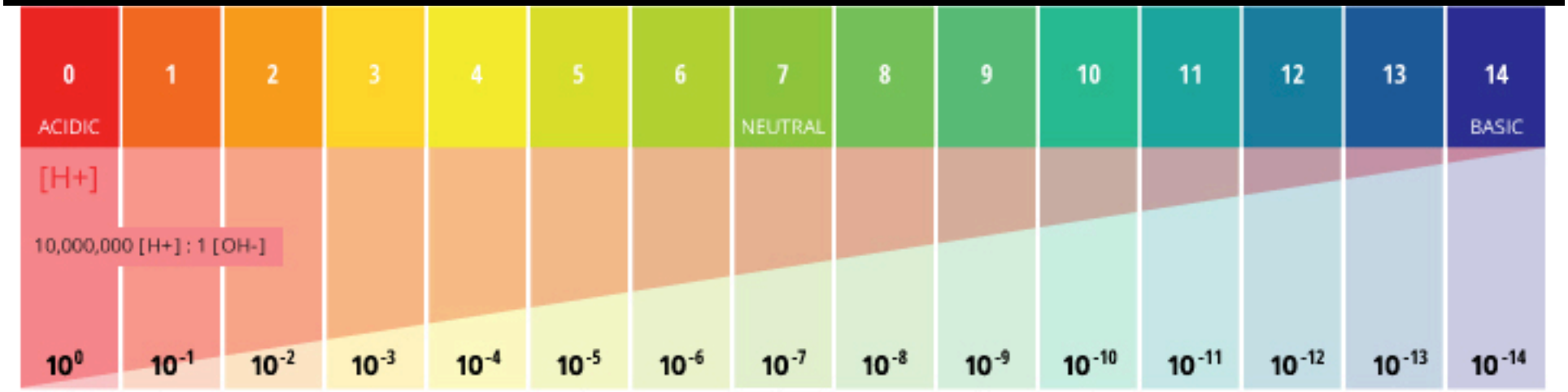
The pH Scale

- **The higher the pH, the more basic the soln' is**


0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Acids
Increasingly acidic
Neutral
Alkalis
Increasingly alkali

The pH Scale

- A change of 1 pH is equivalent to a 10x increase/decrease in acidity
- Ex/ pH 1 is ten times as acidic as pH 2
- Ex/ pH 0 is 10 x 10 = 100 times as acidic as pH 2



Calculating pH and pOH

Calculating pH and pOH

- **Formula given pH/pOH:**

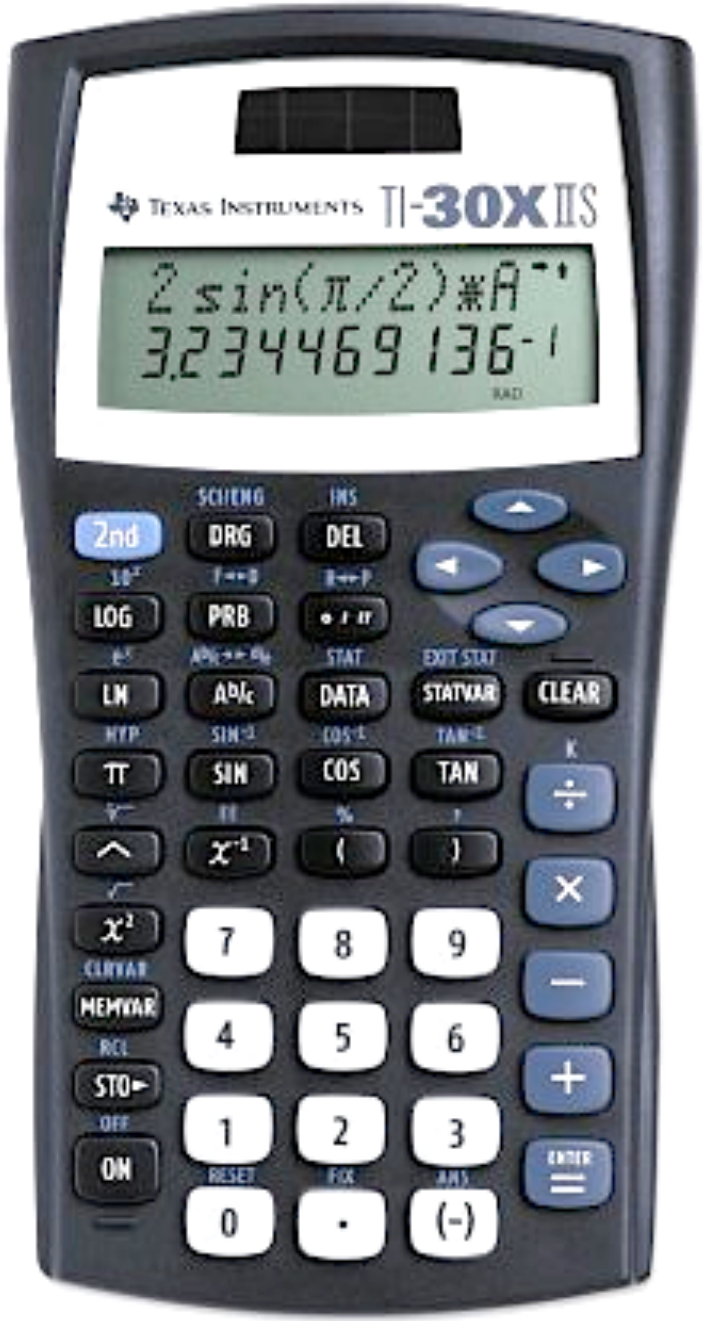
pH + pOH = 14

Example 1

- What is the pOH of a solution if the pH is 5?
- Is the solution acidic or basic?

Ex. 2

- What is the pH of a solution if the pOH is 3.5?
- Is the solution acidic or basic?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Calculating pH and pOH

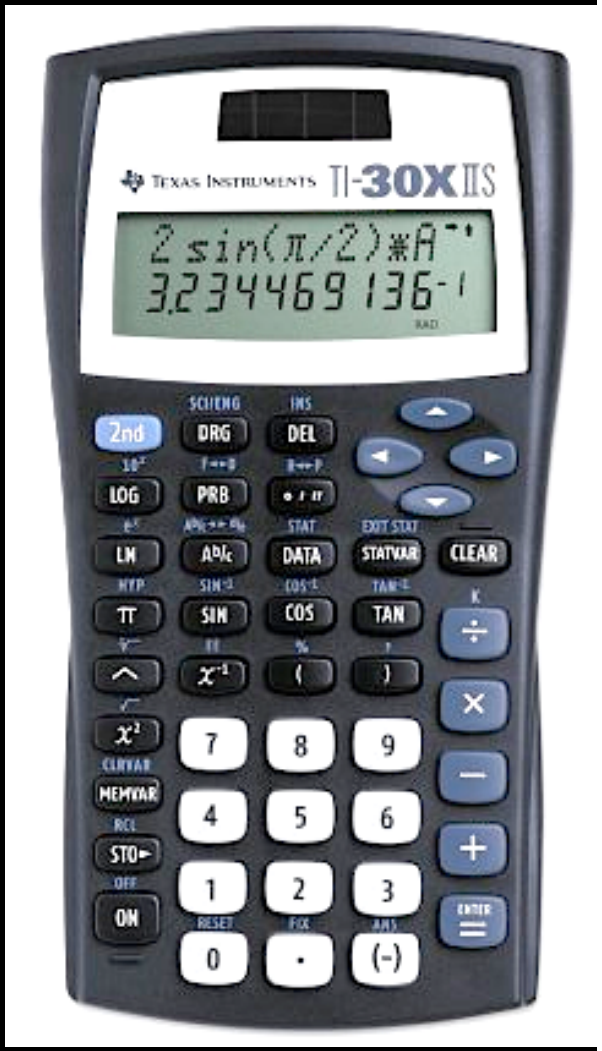
- **Formulas given concentration:**

$$pH = -\log[H^+]$$

$$pOH = -\log[OH^-]$$

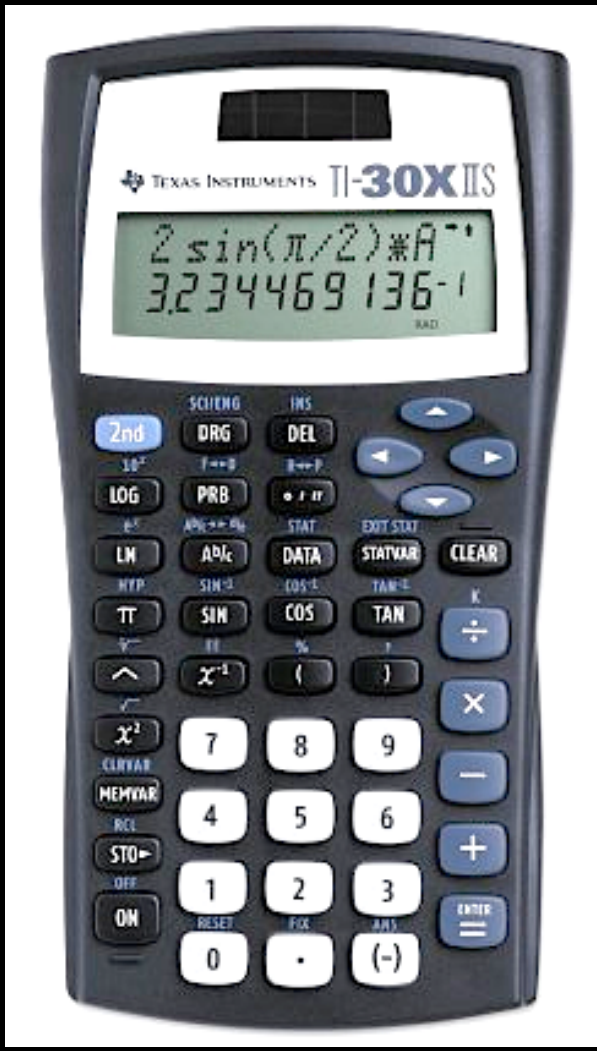
Ex. 3

- What is the pH of a solution if the $[H^+]$ is 1×10^{-6} M?
- Is the solution acidic or basic?



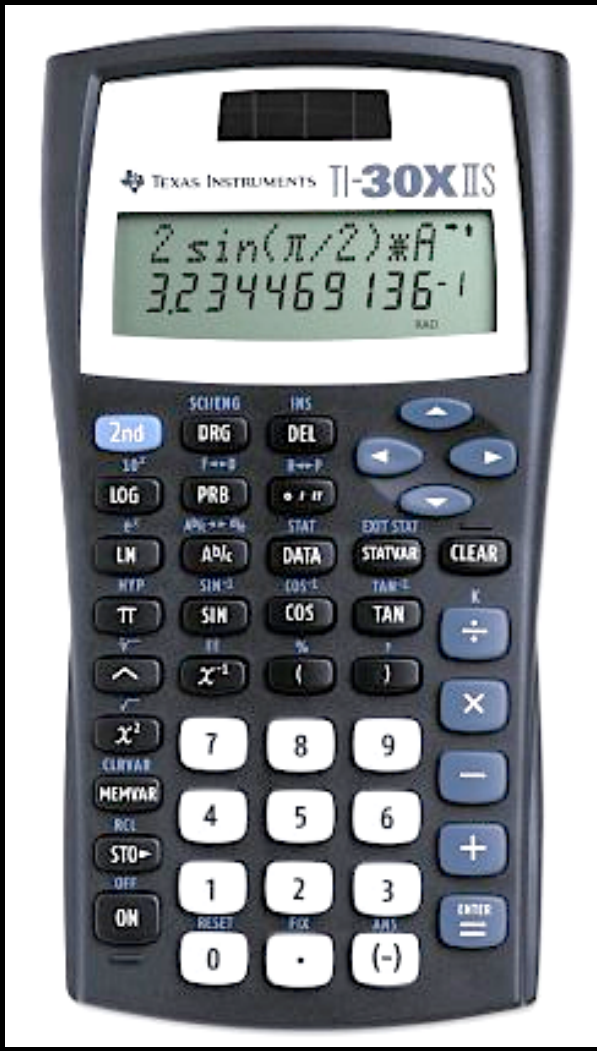
Ex. 4

- What is the pH of a solution if the $[H^+]$ is 4×10^{-10} M?
- Is the solution acidic or basic?



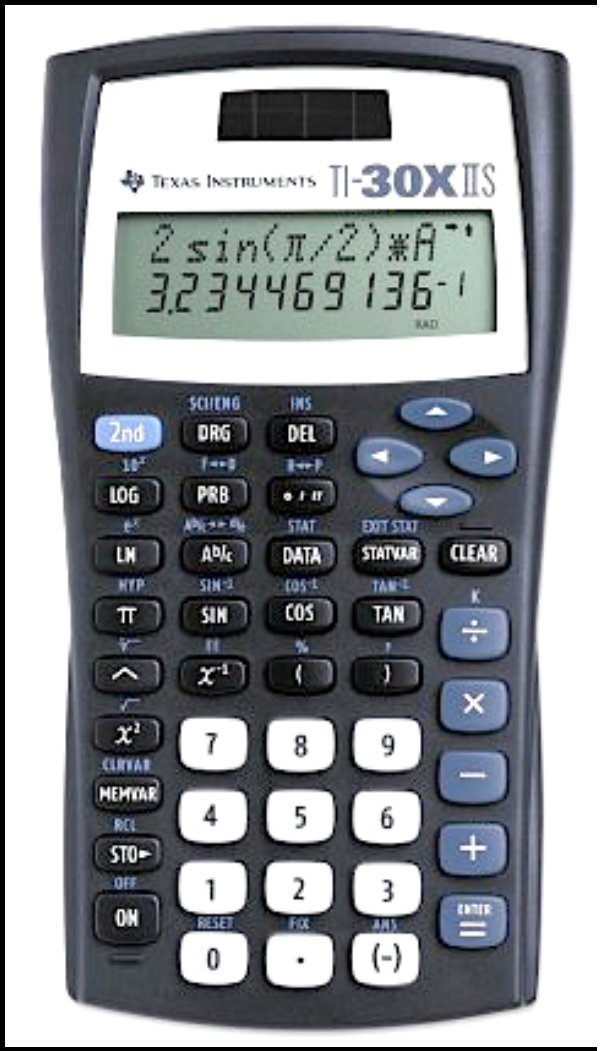
Ex. 5

- What is the pH of a solution if the $[OH^-]$ is 4×10^{-11} M?
- Is the solution acidic or basic?



Ex. 6

- What is the pH of a solution if the $[OH^-]$ is 4.3×10^{-5} M?
- Is the solution acidic or basic?



Calculating pH and pOH

- **Formulas given pH or pOH:**

$$[H^+] = 10^{-pH}$$

$$[OH^-] = 10^{-pOH}$$

Ex. 7

- What is the $[H^+]$ of a solution with a pH of 5.2.

Ex. 8

- What is the [OH^-] of a solution with a pOH of 8.8.

Chemistry

Wednesday, April 25th – Thursday, April 26th, 2018

Do-Now: "**BrainPOP: Acids & Bases**"

1. Write down today's FLT
2. The pH scale ranges from _____ to _____.
3. Which is more acidic: pH 3 or pH 6?
4. Which is more basic: pH 3 or pH 6?
5. If you have a pH of 3, what is your pOH?
6. What is the pH of a solution if the $[H^+]$ is 1.5×10^{-6} M? Show all steps.
7. Take out your planner and ToC

BrainPOP: Acids & Bases

- **Watch the BrainPOP video**
- **After the video, answer the questions in your group – every member must copy down the same answer**
- **The group with the most correct answers → +5 dojo points each**

https://www.brainpop.com/science/matterandchemistry/acidsandbases/

FLT

- I will be able to define strong acids and weak acids & define the products of an acid-base reaction by completing Ch. 16 CN part C

Standard

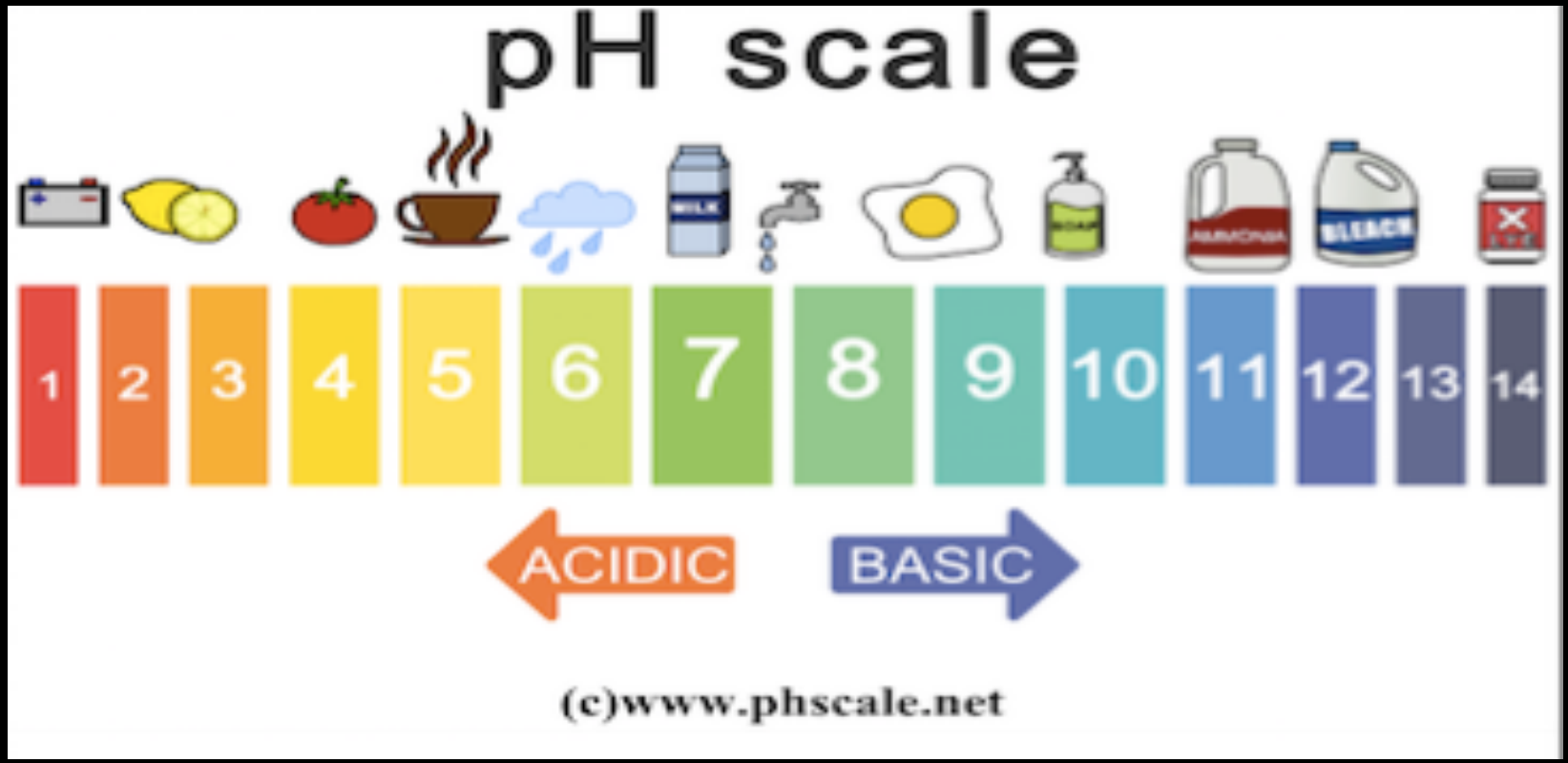
HS-PS3-1: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known

Ch. 16: Acid/Base Strength & Neutralization

Recall

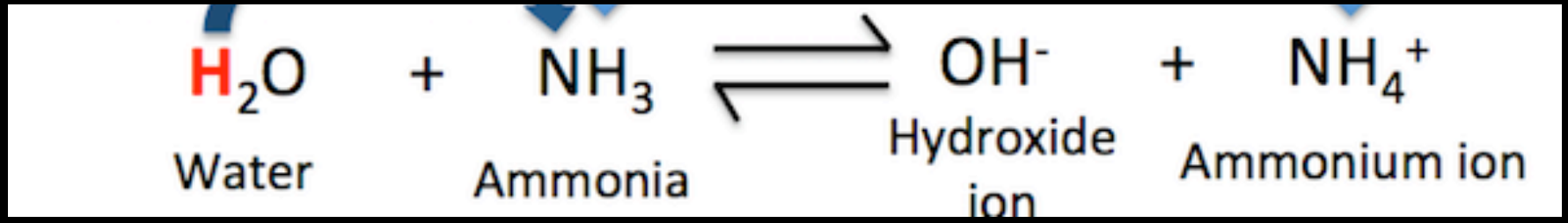
Recall

- The pH scale ranges from 0-14
- What's more acidic?
- What's more basic?



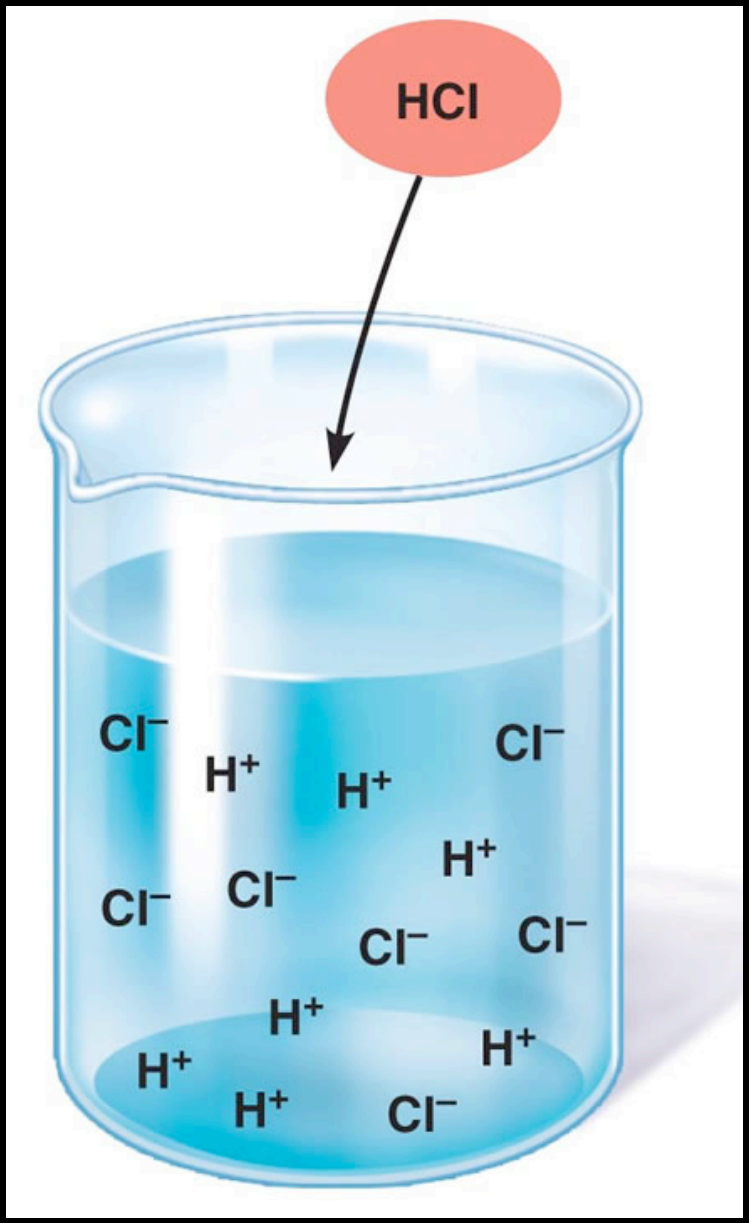
Recall

- Brønsted-Lowry acids:
  - Donate H^+ in water
- Brønsted-Lowry bases:
  - Accept H^+ in water



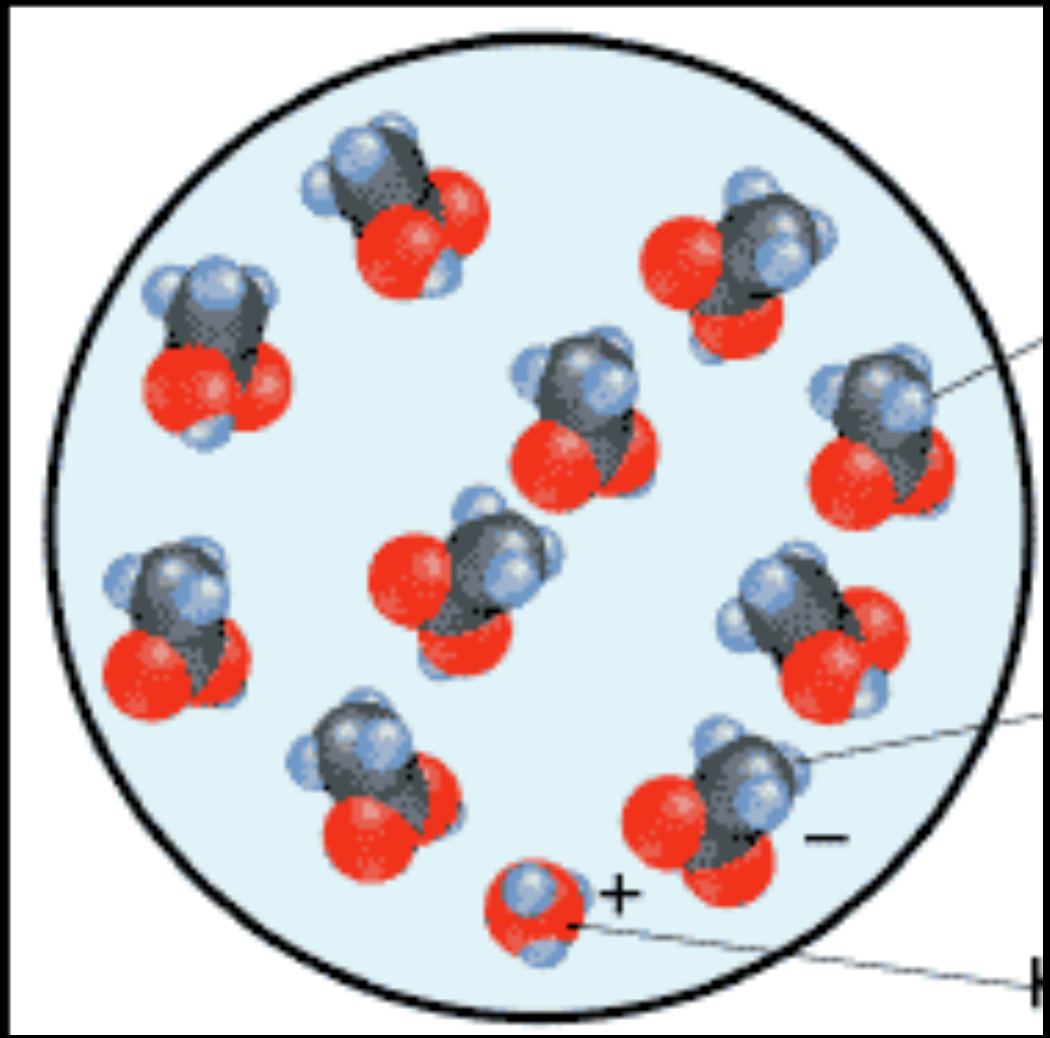
Recall

- Acids and bases are electrolytes
- This means that they dissociate into ions in water



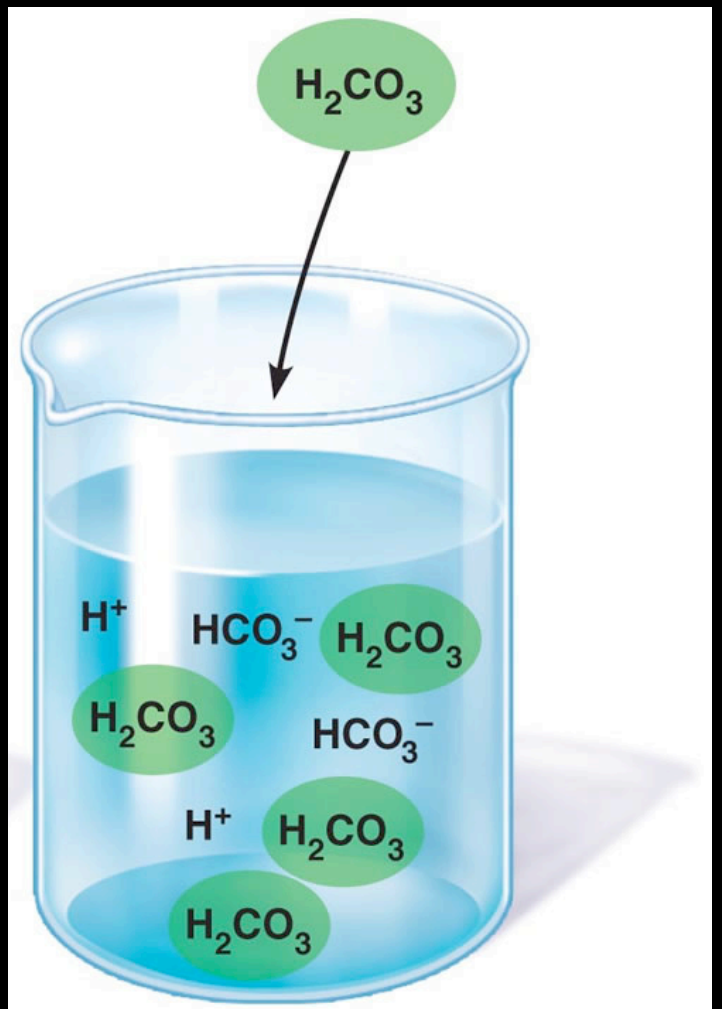
Recall

- What if they only dissociate a little bit?



Electrolytes and Nonelectrolytes

- Weak electrolytes = only partially ionize
  Weak electrolytes have only a fraction of the solute that exists as ions (about 1%)
  - Weak acids and bases; ammonia, acetic acid

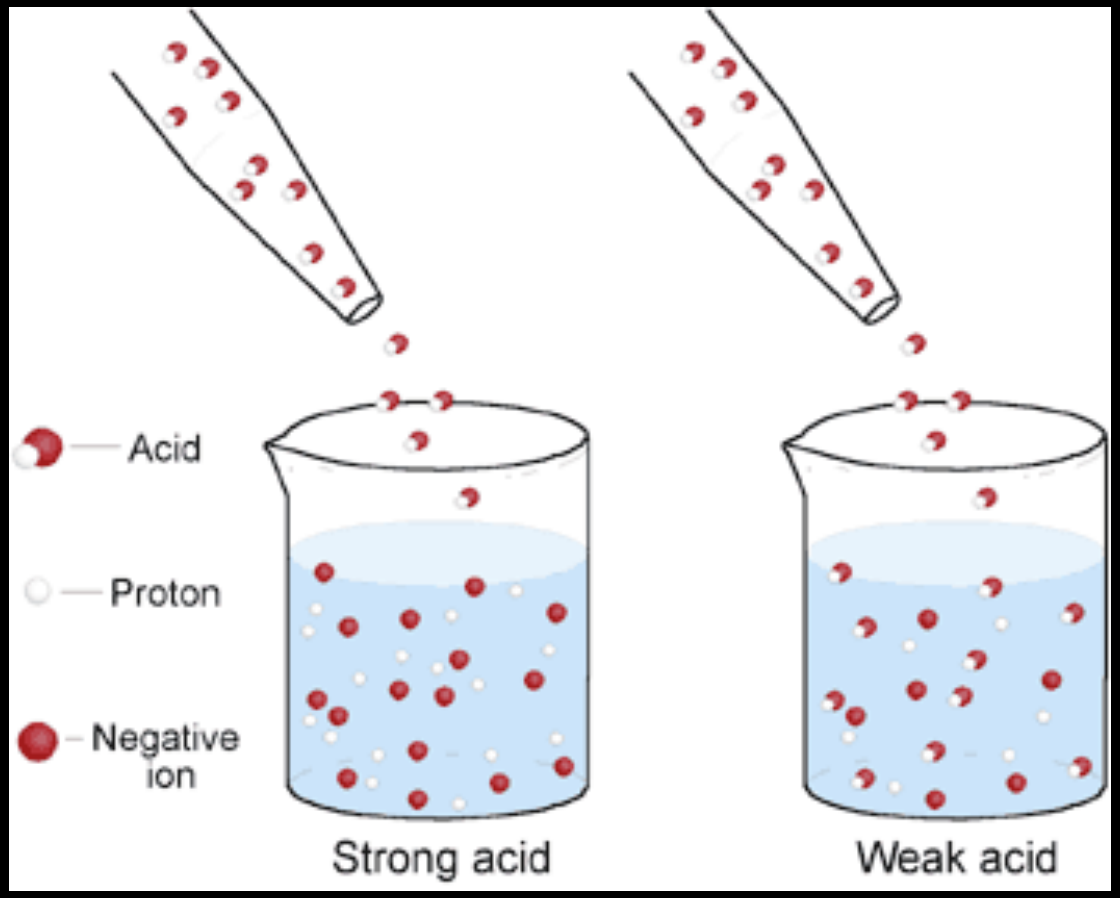


(b) A weak acid such as H_2CO_3 does *not* dissociate completely.

Acid/Base Strength

Acid/Base Strength

- Acids are classified as strong or weak depending on the degree to which they ionize in water



Acid/Base Strength

- **Strong acids = completely ionize in water**
- **Ex/ HCl, HNO_3, H_2SO_4**

$$HCl_{(g)} + H2O_{(l)} \rightarrow H3O^{+}_{(aq)} + Cl^{-}_{(aq)}$$

100% ionized

Acid/Base Strength

- **Weak Acids = ionize only slightly in water.**
- **Ex/ Ethanoic (acetic) acid**

$$CH_3COOH_{(aq)} + H_2O_{(l)} \leftrightarrow H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$$

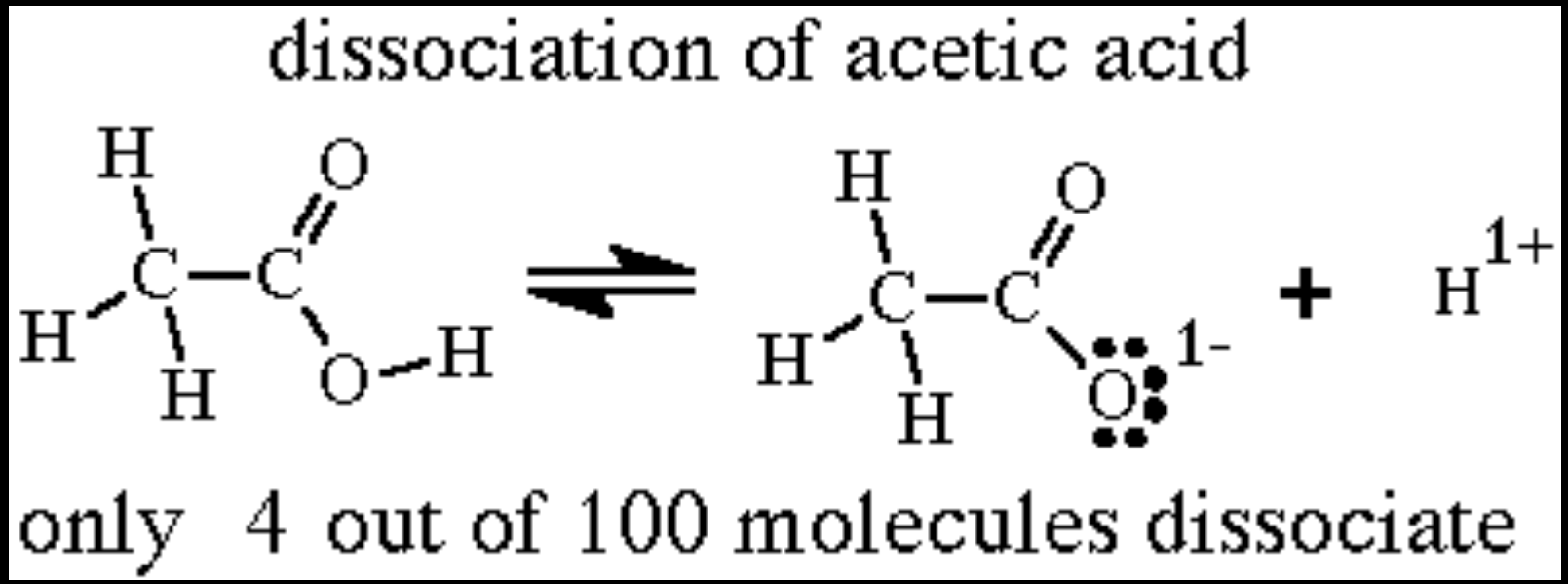


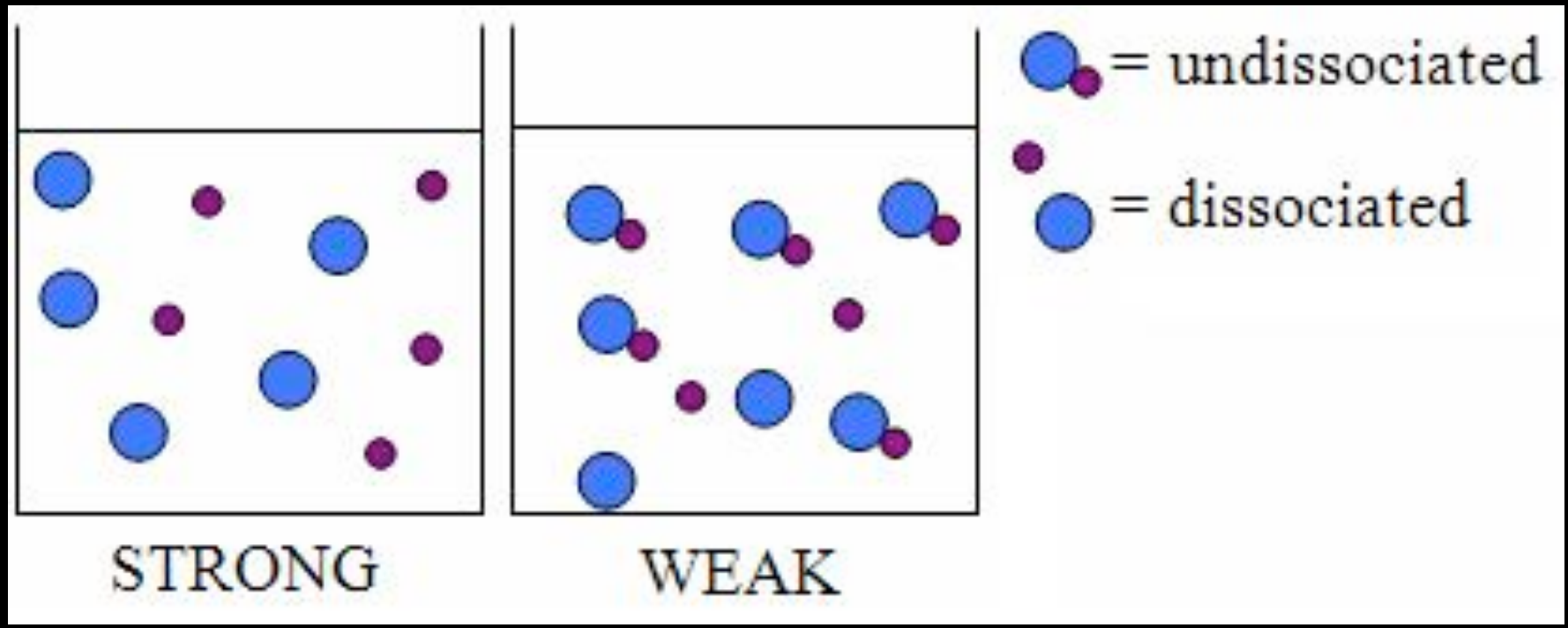
Table 19.6

Relative Strengths of Common Acids and Bases

Substance	Formula	Relative Strength
Hydrochloric acid	HCl	Strong Acid
Nitric acid	HNO_3	Increasing strength of acid
Sulfuric acid	H_2SO_4	
Phosphoric acid	H_3PO_4	
Ethanoic acid	CH_3COOH	
Carbonic acid	H_2CO_3	
Hypochlorous acid	HClO	
Neutral Solution		Neutral Solution
Ammonia	NH_3	
Sodium silicate	Na_2SiO_3	
Calcium hydroxide	$Ca(OH)_2$	Increasing strength of base
Sodium hydroxide	NaOH	
Potassium hydroxide	KOH	Strong Base

Acid/Base Strength

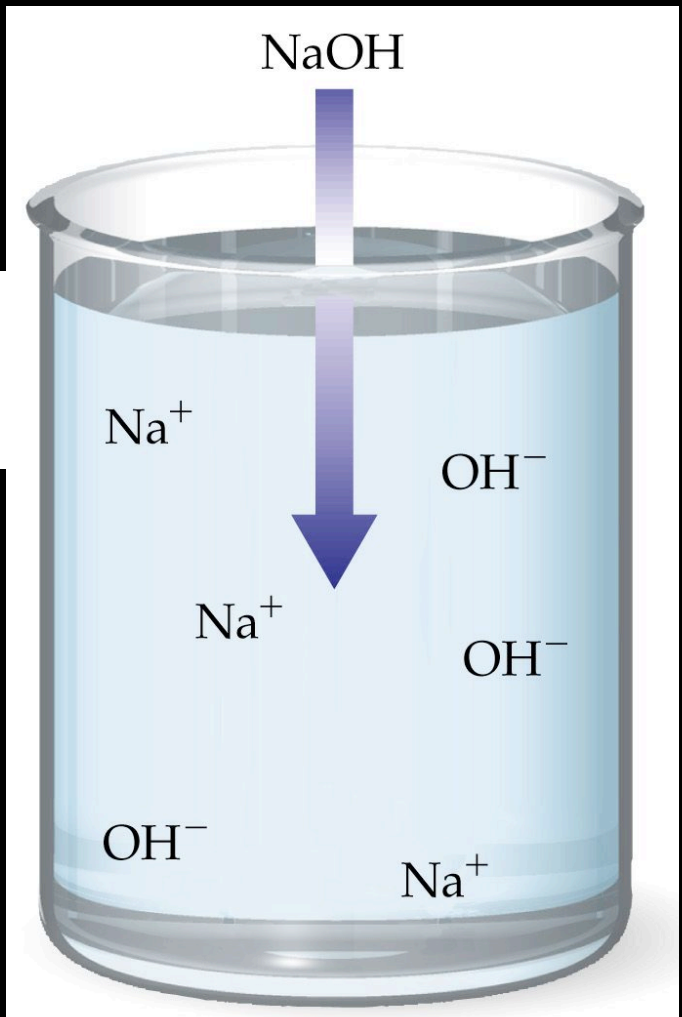
- Bases are also classified as strong or weak depending on the degree to which they ionize in water



Acid/Base Strength

- **Strong bases = completely dissociate into metal ions and OH^- ions in water**
- **Ex/ $Ca(OH)_2$, NaOH, KOH**

$$NaOH(s) \xrightarrow{H_2O(l)} Na^+(aq) + OH^-(aq)$$



Acid/Base Strength

- **Weak Bases = Produce a small amount of OH^- in water**
- **Ex/ Ammonia (NH_3)**

$$NH_{3(aq)} + H_2O_{(l)} \leftrightarrows NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$$

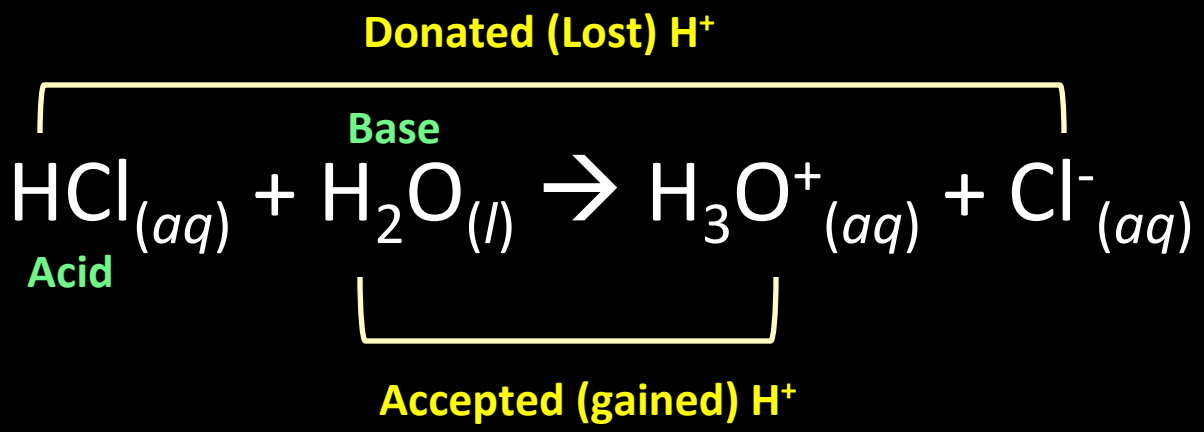
99% NH_3 still present, ~1% ionized

Conjugate Acids & Bases

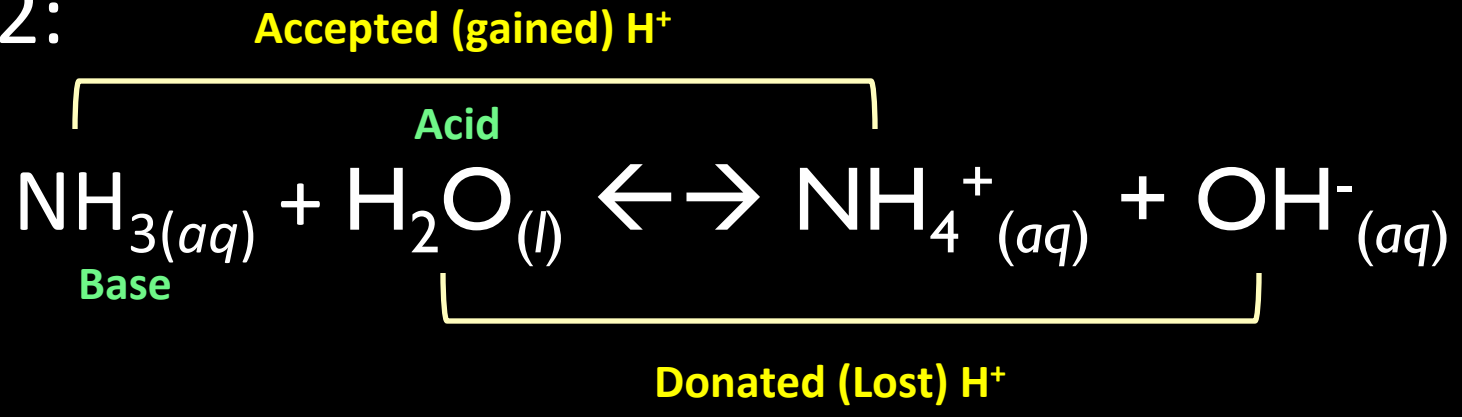
The Brønsted-Lowry Definition

- We can label our acid-base reactions using proton-transfer

- Ex 1:

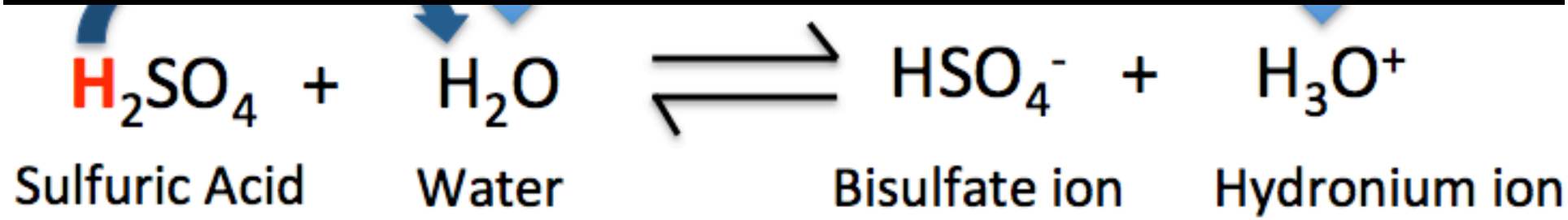


- Ex 2:



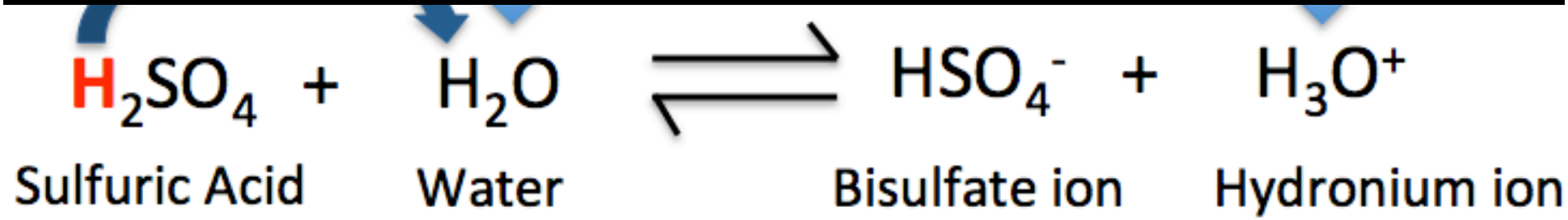
Conjugate Acids & Bases

- In this equation, what is the acid? What is the base?



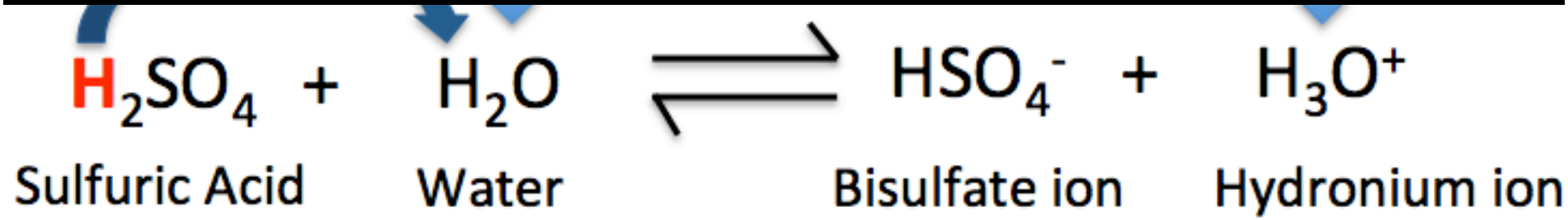
Conjugate Acids & Bases

- Note: This is a reversible reaction. The back reaction is also an acid-base reaction.
- Which is the acid and which is the base?



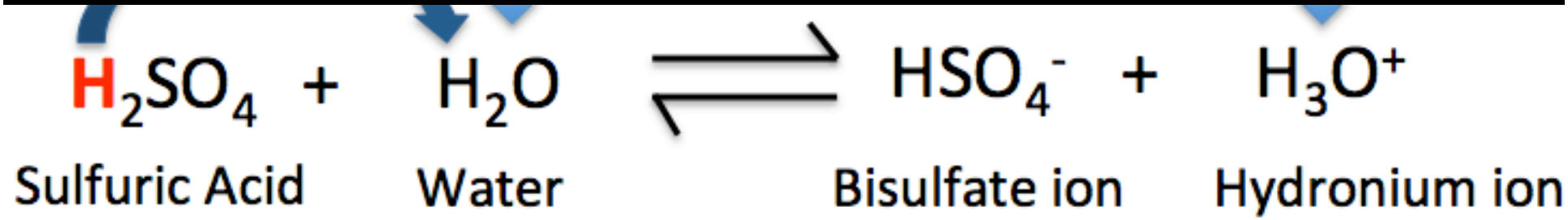
Conjugate Acids & Bases

- **Conjugate Acid = formed when a base gains H^+**



Conjugate Acids & Bases

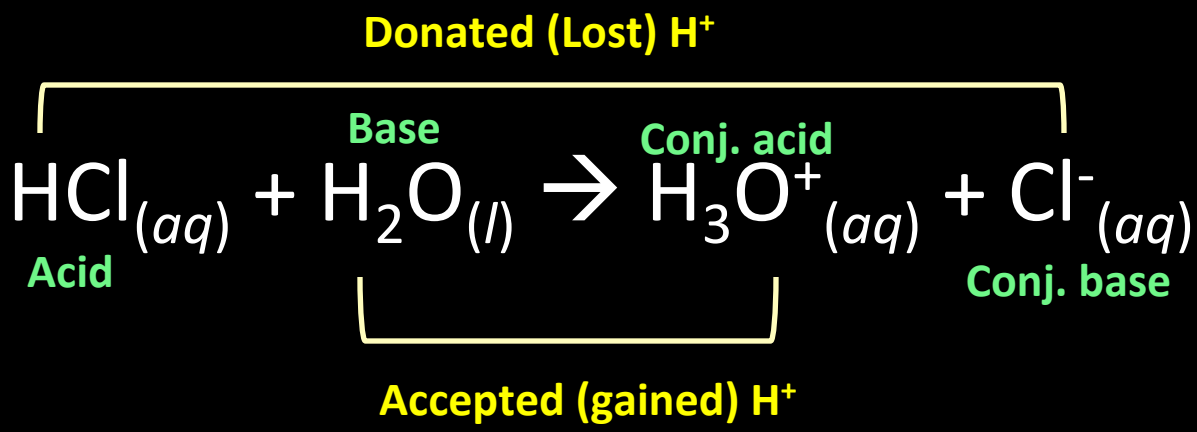
- **Conjugate Base = formed when an acid loses H^+**



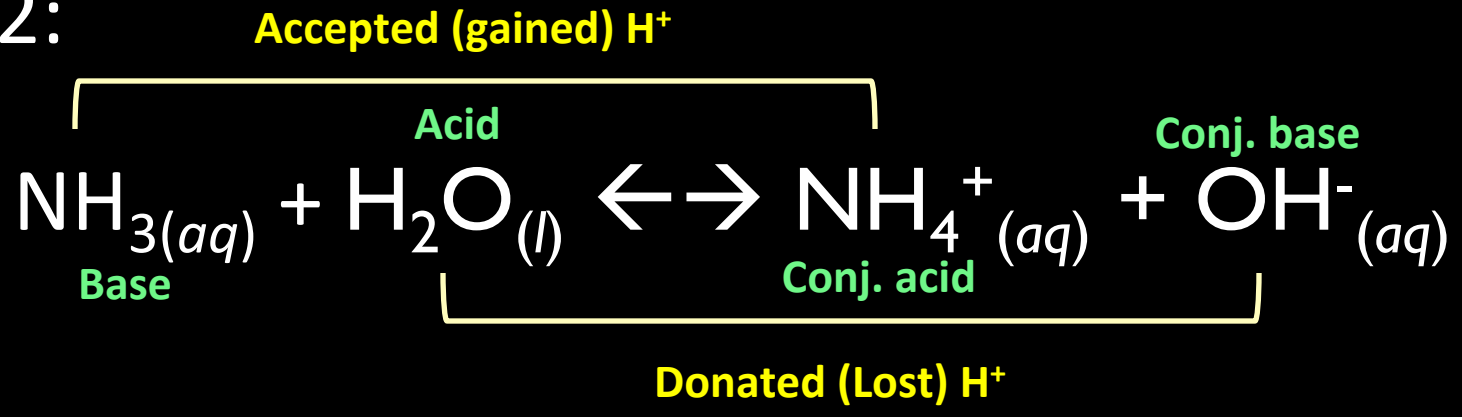
The Brønsted-Lowry Definition

- We can label our acid-base reactions using proton-transfer

- Ex 1:

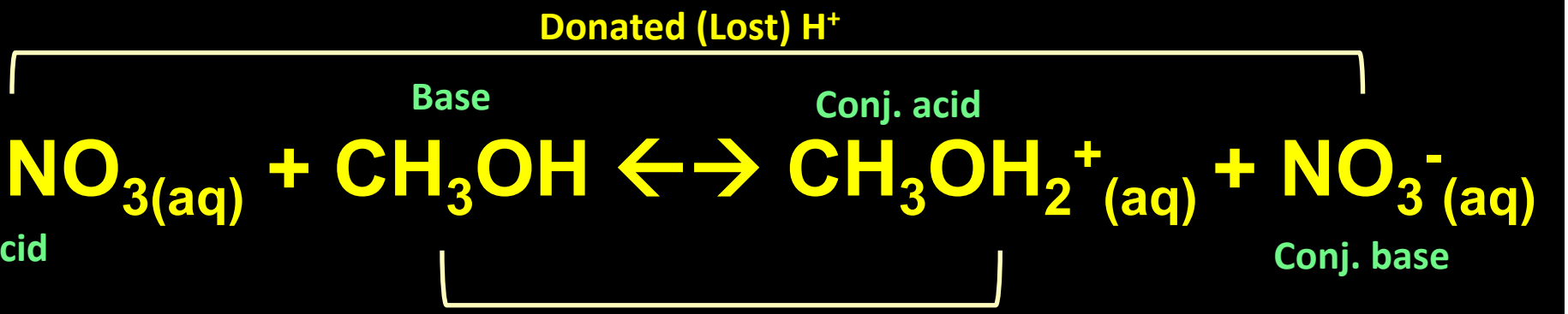


- Ex 2:



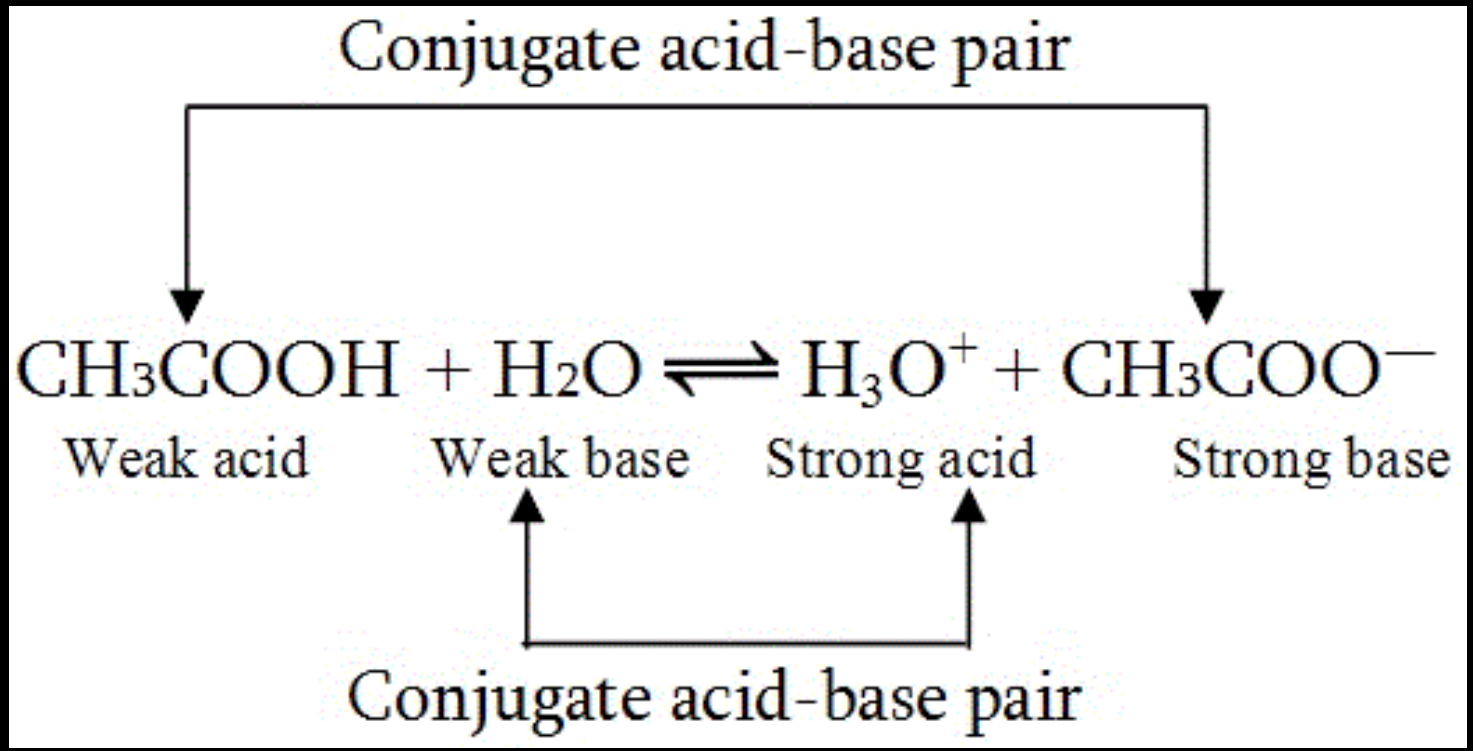
Try This:

- In the equation below, label the acid, base, conjugate acid, and conjugate base.



Conjugate Acids & Bases

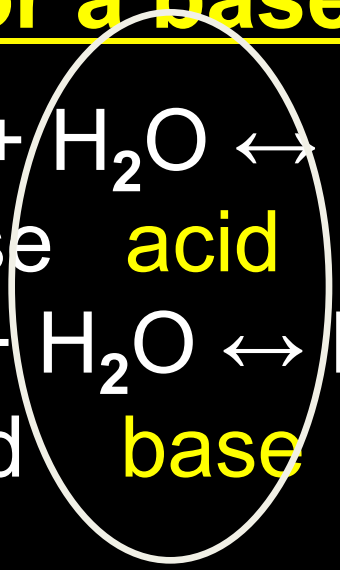
- **Conjugate Acid-Base Pair Strengths:**
  - **Strong acids/bases form weaker conjugates**
  - **Weak acids/bases form stronger conjugates**



Last Tidbits

Last Tidbits

- **Amphoteric substances = act as both an acid or a base**



$NH_3 + H_2O \leftrightarrow NH_4^{1+} + OH^{1-}$

base acid c.a. c.b.

$HCl + H_2O \leftrightarrow H_3O^{1+} + Cl^{1-}$

acid base c.a. c.b.

Last Tidbits

- Neutralization Reaction - a reaction in which an acid and a base react in an aqueous solution to produce a salt and water:

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

$H_2SO_{4(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4(aq)} + 2\ H_2O_{(l)}$

  - Table 19.9, page 613 lists some salts

Last Tidbits

- Acid + Base → Water + Salt
- Properties related to every day:
  - antacids depend on neutralization
  - farmers adjust the soil pH
  - formation of cave stalactites
  - human body kidney stones from insoluble salts

Pair-Share-Respond

1. **Distinguish between strong and weak acids**
2. **Distinguish between strong and weak bases**
3. **What are conjugate acids?**
4. **What are conjugate bases?**
5. **How can you determine if your conjugate acid/base is strong or weak?**