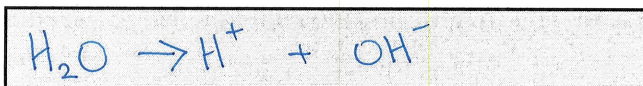


Acids and Bases (All About That Base)

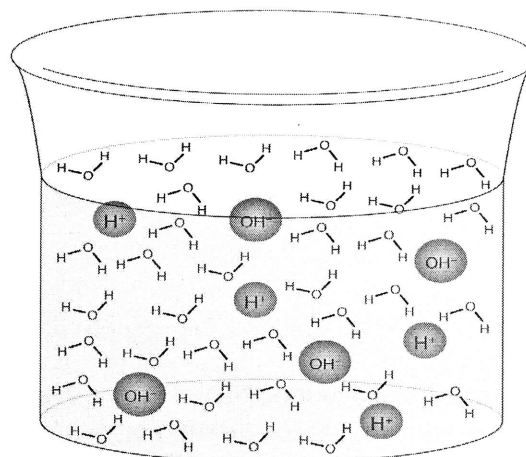
Ions and Water

Water naturally dissociates (breaks apart) into its ions according to the formula:



In any aqueous (water-based) solution, there will be some hydrogen (H^+) ions and some hydroxide (OH^-) ions, alongside the actual water molecules.

A **neutral solution** is one where the concentration of H^+ and OH^- ions is equal. For every H^+ ion, there will be one OH^- ion.



https://saylordotorg.github.io/text_the-basics-of-general-organic-and-biological-chemistry/s13-03-water-both-an-acid-and-a-base.html

pH Scale

pH is used to determine the relative concentration of H^+ and OH^- ions in solution. It is a logarithmic scale.

In a neutral solution with a pH of 7, the amount of H^+ and OH^- ions is equal. The concentration of H^+ ions is 10^{-7} M, and the concentration of OH^- ions is 10^{-7} M.

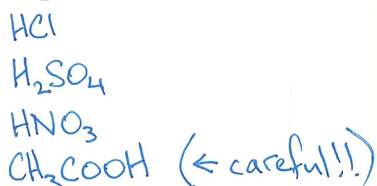
Acids and Bases

Acids are ionic compounds containing the H^+ cation. When dissolved, the ions dissociate (separate), so that the concentration of H^+ ions increases and the concentration of OH^- ions decreases.

Properties of acids:

- pH less than 7
- Taste sour (often in drinks!)
- Burn skin
- React with metals
- Conduct electricity

Examples of acids:



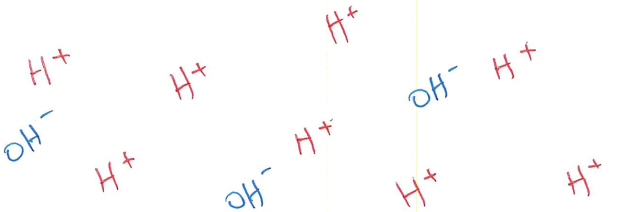
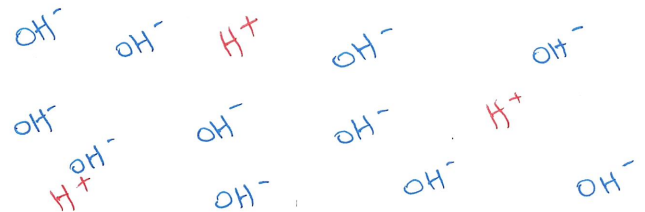
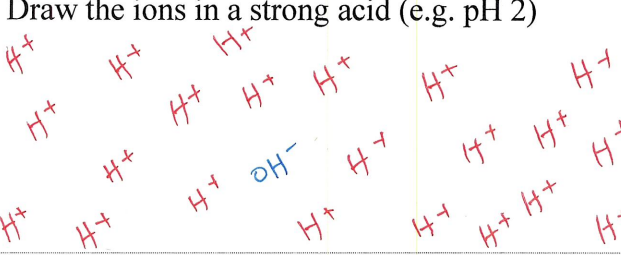
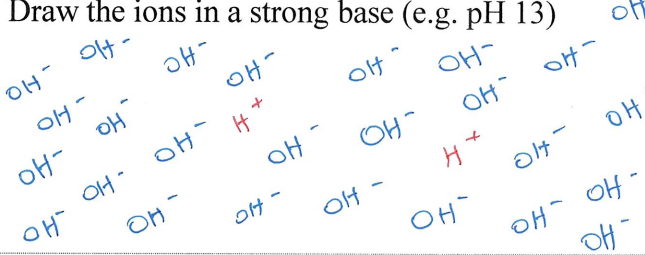
How to tell acids and bases apart from their formulas:

acids have H^+ ion (usually on left); bases have OH^- anion (on right)

Molarity

M or Molarity is a derived unit representing moles/Liters. (A mole represents a very large number of particles.)

M is a unit of concentration. The higher the Molarity, the higher the concentration, and the more particles there are in that space. The lower the Molarity, the lower the concentration, and the fewer particles there are in that space.

<p>Draw the ions in an acid (e.g. pH 6)</p> 	<p>Draw the ions in a base (e.g. pH 8)</p> 
<p>Draw the ions in a strong acid (e.g. pH 2)</p> 	<p>Draw the ions in a strong base (e.g. pH 13)</p> 
<p>The stronger the acid, the <u>lower</u> the pH, and the greater the concentration of <u>H⁺</u> compared to <u>OH⁻</u>.</p>	<p>The stronger the base, the <u>higher</u> the pH, and the greater the concentration of <u>OH⁻</u> compared to <u>H⁺</u>.</p>

pH and Concentration Calculations

pH	Identity	Concentration of H ⁺ (M)	Concentration of OH ⁻ (M)
1	Acid	10 ⁻¹ 0.1 (high)	10 ⁻¹³ 0.0000000000001 (very low)
3	Acid	10 ⁻³	10 ⁻¹¹
5	Acid	10 ⁻⁵	10 ⁻⁹
7	Neutral	10 ⁻⁷	10 ⁻⁷
9	Base	10 ⁻⁹	10 ⁻⁵
11	Base	10 ⁻¹¹	10 ⁻³
13	Base	10 ⁻¹³ 0.0000000000001 (very low)	10 ⁻¹ 0.1 (high)

pH can be used to calculate ion concentration and vice versa. Examine the above table and use it to answer the following questions. (Reminder: 10⁻¹ = 0.1; 10⁻² = 0.01; 10⁻³ = 0.001; etc.)

- How can you use pH to determine whether something is acidic, neutral or basic?
 acid: pH less than 7
 neutral: pH 7
 base: pH greater than 7
- How do you use ion concentration to determine whether something is acidic, neutral, or basic?
 Look at superscripts, which are linked to pH. (see #3 + #4)



- How do you use pH to find the concentration of H⁺ ions in solution?
 H⁺ concentration = 10^{-pH} e.g. pH 4 ⇒ 10⁻⁴ is the H⁺ concentration
- How do you use pH to find the concentration of OH⁻ ions in solution?
 OH⁻ concentration = 10^{-(14-pH)}} e.g. pH 4 ⇒ 10⁻¹⁰ is the OH⁻ concentration

Comparing Solutions Using pH and Ion Concentrations

You may be asked to compare two different solutions.

Use the following formula:

$$\text{Difference in Strength or Concentration} = 10^{\text{pH difference}}$$

Tips:

- When calculating pH difference, make sure to subtract the smaller pH from the larger one.
- When drawing your conclusion, remember: lower pH = more acidic (less basic); higher pH = more basic (less acidic).

Example: How many times more acidic is lemon juice than tomatoes?

$$\text{Difference in Strength} = 10^{\text{pH difference}} = 10^{4-2} = 10^2 = 100$$

Conclusions:

- **Lemon juice is 100x more acidic than tomatoes.**
- Tomatoes is 100x more basic than tomatoes.
- Lemon juice has a 100x greater concentration of H^+ ions than tomatoes.
- Tomatoes has a 100x greater concentration of OH^- ions than lemons.

Example: Chicken soup has a pH of 5.80. Orange juice has a pH of 3.50. Which is more acidic? By how many times?

$$\text{Difference in Strength} = 10^{\text{pH difference}} = 10^{5.80-3.50} = 10^{2.30} = 200$$

Conclusions:

- **Orange juice is 200x more acidic than chicken soup.**
- Chicken soup is 200x more basic than orange juice.
- Orange juice has a 200x greater concentration of H^+ ions than chicken soup.
- Chicken soup has a 200x greater concentration of OH^- ions than orange juice.

5) Compare the following solutions. For each, state:

i) Which is more acidic or basic?

ii) How many times more acidic or basic?

a) Soap and eggs

pH ↓ 10 pH ↓ 8

$$10^{10-8} = 10^2 = 100 \text{ times}$$

b) Oven cleaner and baking soda

pH ↓ 13 pH ↓ 9

$$10^{13-9} = 10^4 = 10,000 \text{ times}$$

c) Vinegar (pH 2.9) and milk

pH ↓ 6

$$10^{6-2.9} = 10^{3.1} = 1259 \text{ times}$$

d) Seawater (pH 7.7) and human blood (pH 7.3)

$$10^{7.7-7.3} = 10^{0.4} = 2.5 \text{ times}$$

Acid-Base Indicators

Indicators are used to determine the approximate pH of a substance. There are many different kinds of indicators.

6) What colour will each of the indicators be in a solution with the following pHs?

	2	4	6.5	9	12
Methyl orange	red	orange	yellow	yellow	yellow
Phenolphthalein	colourless	colourless	colourless	light pink	pink
Litmus	red	red	red	blue	blue
Bromothymol blue	yellow	yellow	green	blue	blue
Indigo carmine	blue	blue	blue	blue	green

7) What colour will phenolphthalein be in a solution with a OH^- concentration of 10^{-4} M ?

OH^- concentration of 10^{-4} M is a pH of 10.
Phenolphthalein is pink.

Lab 5-1B (Green Science 10 Textbook)

Observations

	Magnesium ribbon	Red litmus	Blue litmus	Bromothymol blue	Indigo carmine	Methyl orange
A	no reaction	red?	purple?	green	blue	yellow
B	no reaction	blue	blue	blue	blue	yellow
C	reaction (bubbles)	red	red	yellow	blue	red
D	no reaction	blue	blue	blue	yellow	yellow

Questions (answer on separate sheet of paper)

- List the solutions in order from most acidic to least acidic (most basic). C, A, B, D
 - Which solution do you think was neutral? Explain how you know. A
 - You used two bases. Explain how you know which solution was more alkaline (more basic).
 - indigo carmine only turns yellow in very strong bases (pH > 13)
 - What colour would each of the five indicators be in a solution that is pH 3?
 - What colour would each of the five indicators be in a solution that is pH 10?
- a. Mg reaction, red, yellow, blue, red
 b. Mg no reaction, blue, blue, blue, yellow } (left to right... Mg, litmus, bromothymol blue, indigo carmine, methyl orange)