Acids and Bases Are Everywhere

Every liquid you see will probably have either acidic or basic traits. Water (H_2O) can be both an acid and a base, depending on how you look at it. It can be considered an acid in some reactions and a base in others. Water can even react with itself to form acids and bases. It happens in really small amounts, so it won't change your experiments at all. It goes like this:

$2H_2O \rightarrow H_3O^+ + OH^-$

See how the hydrogen ion was transferred?

Most of the time, the positive and negative ions in distilled water are in equal amounts and cancel each other out. Most water you drink from the tap has other ions in it. Those special ions in solution make something acidic or basic. In your body there are small compounds called amino acids. The name tells you those are acids. In fruits there is something called citric acid. That's an acid too. But what about baking soda? When you put that in water, it creates a basic solution. Vinegar? Acid.

So what makes an acid or a base? A chemist named Svante Arrhenius came up with a way to define acids and bases in 1887. He saw that when you put molecules into water, sometimes they break down and release an H^+ (hydrogen) ion. At other times, you find the release of an OH^- (hydroxide) ion. When a hydrogen ion is released, the solution becomes acidic. When a hydroxide ion is released, the solution becomes basic. Those two special ions determine whether you are looking at an acid or a base. For example, vinegar is also called acetic acid. (Okay, that gives away the answer.) If you look at its atoms when it's in water, you will see the molecule CH_3COOH split into CH_3COO^- and H^+. That hydrogen ion is the reason it is called an acid. Chemists use the word "dissociated" to describe the breakup of a compound.

Scientists use something called the pH scale to measure how acidic or basic a liquid is. Although there may be many types of ions in a solution, pH focuses on concentrations of hydrogen ions (H^+) and hydroxide ions (OH^-). The scale measures values from 0 all the way up to 14. Distilled water is 7 (right in the middle). Acids are found between 0 and 7. Bases are from 7 to 14. Most of the liquids you find every day have a pH near 7. They are either a little below or a little above that mark. When you start looking at the pH of chemicals, the numbers can go to the extremes. If you ever go into a chemistry lab, you could find solutions with a pH of 1 and others with a pH of 14. There are also very strong acids with pH values below 1, such as battery acid. Bases with pH values near 14 include drain cleaner and sodium hydroxide (NaOH). Those chemicals are very dangerous.

Names to Know

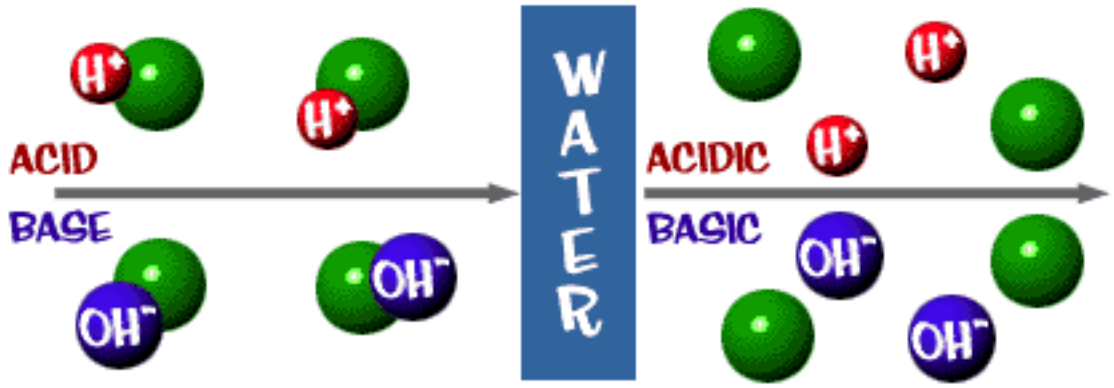
Let's look at the whole picture now. There is a scale for acids and bases just like everything else. Here are a couple of definitions you should know:

Acid: A solution that has an excess of H^+ ions. It comes from the Latin word acidus, which means "sharp" or "sour".
Base: A solution that has an excess of OH^- ions. Another word for base is alkali.
Aqueous: A solution that is mainly water. Think about the word aquarium. AQUA means water.
Strong Acid: An acid that has a very low pH (0-4).
Strong Base: A base that has a very high pH (10-14).
Weak Acid: An acid that only partially ionizes in an aqueous solution. This means that not every molecule breaks apart. Weak acids usually have a pH close to 7 (3-6).
Weak Base: A base that only partially ionizes in an aqueous solution. This means that not every

molecule breaks apart. Weak bases usually have a pH close to 7 (8-10).
Neutral: A solution that has a pH of 7. It is neither acidic nor basic.

More Ideas About Acids and Bases

We told you about that guy Arrhenius and his ideas about concentrations of hydrogen and hydroxide ions. You're also going to learn about Brønsted-Lowry ideas. These two chemists from Denmark and England looked at acids as donors and bases as acceptors. What were they donating and accepting? Hydrogen ions. It's a lot like the first definition we gave, where an acid breaks up and releases/donates a hydrogen ion. This newer definition is a little bit more detailed. Scientists used the new definition to describe more bases, such as ammonia (NH_3). Since bases are proton acceptors, when ammonia was seen accepting an H+ and creating an ammonium ion (NH_4^+), it could be labeled as a base. You didn't have to worry about hydroxide ions anymore. If it got the H+ from a water molecule, then the water (H_2O) was the proton donor. Does that mean the water was the acid in this situation? Yes.



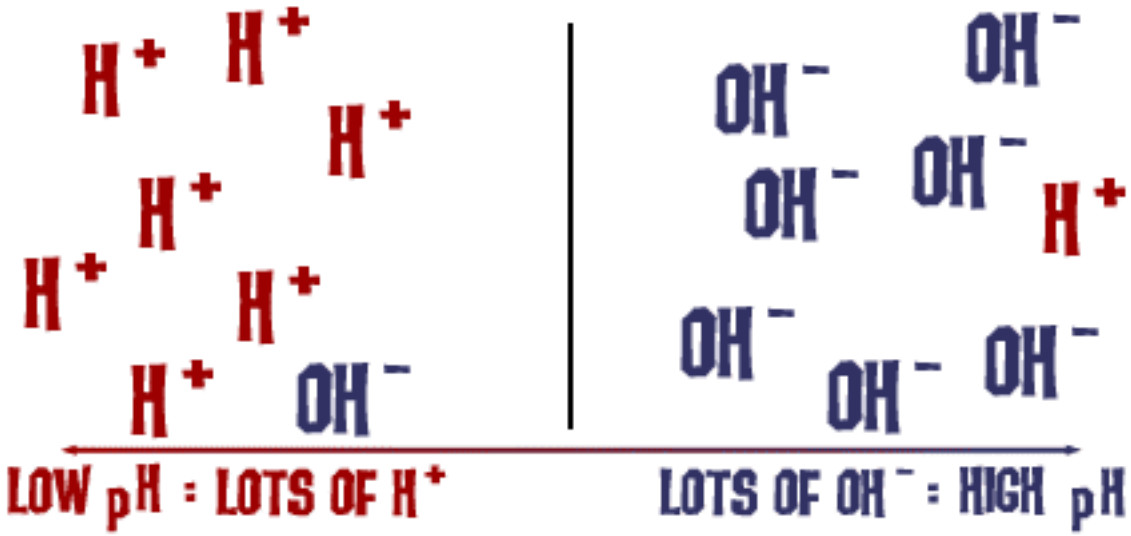
A chemist named Lewis offered a third way to look at acids and bases. Instead of looking at hydrogen ions, he looked at pairs of electrons (remember our pictures with dot structures in Atoms and Elements?). In Lewis' view, acids accept pairs of electrons and bases donate pairs of electrons. We know that both of these descriptions of acids and bases use completely opposite terms, but the idea is the same. Hydrogen ions still want to accept two electrons to form a bond. Bases want to give them up. Overall, Lewis' definition was able to classify even more compounds as acids or bases.

What Really Happens

What really happens in those solutions? It gets a little tricky here. Let's look at the breakup of molecules in aqueous (water-based) solutions one more time for good measure. Acids are compounds that dissociate (break) into hydrogen (H+) ions and another compound when placed in an aqueous solution. Remember that acetic acid example? Bases are compounds that break up into hydroxide (OH^-) ions and another compound when placed in an aqueous solution. We'll talk about baking soda in a few paragraphs.

Let's change the wording a bit. If you have an ionic/electrovalent compound and you put it in water, it will break apart into two ions. If one of those ions is H^+, the solution is acidic. The strong acid hydrogen chloride (HCl) is one example. If one of the ions is OH^-, the solution is basic. An example of a strong base is sodium hydroxide (NaOH). There are other ions that make acidic and basic solutions, but we won't be talking about them here.

That pH scale we talked about is actually a measure of the number of H^+ ions in a solution. If there are a lot of H^+ ions, the pH is very low. If there are a lot of OH^- ions compared to the number of H^+ ions, the pH is high.



Think about this idea for a second: Why would a liquid with high levels of NaOH be very basic, yet dangerous at the same time? The Na-OH bond breaks in solution and you have sodium ions (positive) and hydroxide ions (negative). The sodium ions don't really pose a danger in solution, but there are a huge number of hydroxide ions in solution compared to the hydrogen ions that might be floating around as H_3O^+ (a hydronium ion).All of those excess OH^- ions make the pH super high, and the solution will readily react with many compounds. The same thing happens on a less dangerous scale when you add baking soda to water. During the dissociation, OH^- ions and carbonic acid are released in the solution. The number of OH^- ions is greater than the number of H_3O^+ ions (H^+ and H_2O), and the pH increases. It's just not as strong a difference as in sodium hydroxide.

That's basically it. (Ha ha! Get it?)

Name_____Period_____

1. Acids are electron acceptors. True or False

2. Every liquid is either and acid or a base. True or False

3. A positively charged ion is called a
    a. Dogion
    b. Cation
    c. Neutrion
    d. None of the above

4. There are a variety of strengths when you study acids and bases. True or False

5. What is the term for the positive and negative ions of a compound breaking apart in solution?
    a. Conglomeration
    b. Oxidation
    c. Dissociation
    d. Procrastination

6. pH is a measure of ____ ions.
    a. Hydroxide
    b. Hydrogen
    c. Aqueous
    d. Hydronium

7. What is the term for a water molecule that gains an extra hydrogen ion?
    a. Hydroxium ion
    b. Hydronium ion
    c. Hydroxide ion
    d. None of the above

8. An aqueous solution is one that has compounds dissolved in water. True or False

9. Acids and bases can combine to create water and salts. True or False