NAME: **HONORS CHEMISTRY**

SECTION: Operational Definitions of Acids and Bases

The words acid and alkaline (an older word for base) are derived from direct sensory experience.

**Acid Property #1:** The word acid comes from the Latin word *acere*, which means "sour." All acids taste sour. Well known from ancient times were vinegar, sour milk and lemon juice. Aspirin (scientific name: acetylsalicylic acid) tastes sour if you don't swallow it fast enough. Other languages derive their word for acid from the meaning of sour. So, in France, we have *acide.* In Germany, we have *säure* from *saure* and in Russia, *kislota* from *kisly.*

**Base Property #1:** The word "base" has a more complex history and its name is not related to taste. All bases taste bitter. For example, mustard is a base. It tastes bitter. Many medicines, because they are bases, taste bitter. This is the reason cough syrups are advertised as having a "great grape taste." The taste is added in order to cover the bitterness of the active ingredient in cough syrup.

**Acid Property #2A:** Acids make a blue vegetable dye called [litmus](http://en.wikipedia.org/wiki/Litmus_test_%28chemistry%29) turn red.

**Acid Property #2B:** In the presence of acids, the acid-base indicator phenolphthalein is colorless. Before 1999 phenolphthalein was used as the active ingredient in Exlax, as it is a powerful laxative.

**Base Property #2:** Bases are substances which will restore the original blue color of litmus after having been reddened by an acid.

**Base Property #2B**: In the presence of bases, phenolphthalein turns a vivid magenta color.

**Acid Property #3:** Acids destroy the chemical properties of bases.

**Base Property #3:** Bases destroy the chemical properties of acids.

Neutralization is the name for this type of reaction.

**Acid Property #4:** Acids conduct an electric current.

**Base Property #4:** Bases conduct an electric current.

This is a common property shared with salts. Acids, bases and salts are grouped together into a category called electrolytes, meaning that a water solution of the given substance will conduct an electric current.

Non-electrolyte solutions cannot conduct a current. The most common example of this is sugar dissolved in water.

So far, the properties have an obvious relationship: taste, color change, mutual destruction, and response to electric current. This last property is related, but in a less obvious way. The property below identifies a unique chemical reaction that acids and bases engage in.

**Acid Property #5:** Upon chemically reacting with an **active** metal, acids will evolve hydrogen gas (H2). The key word, of course, is active. Some metals, like gold, silver or platnium, are rather unreactive and it takes rather extreme conditions to get these "unreactive" metals to react. Not so with the metals in this property. They include the alkali metals (Group I, Li to Rb), the alkaline earth metals (Group II, Be to Ra), as well as zinc and aluminum. Just bring the acid and the metal together at anything close to room temperature and you get a reaction. Here's a sample reaction:

Zn + 2 HCl(aq) → ZnCl2 + H2

Another common acid reaction some sources mention is that acids react with carbonates (and bicarbonates) to give carbon dioxide gas:

HCl + Na2CO3 → CO2 + H2O + NaCl

**Base Property #5:** Bases feel slippery; sometimes people say soapy. This is because they dissolve the fatty acids and oils from your skin and this cuts down on the friction between your fingers as you rub them together. In essence, the base is making soap out of you. Yes, bases are involved in the production of soap! In the early years of soap making, the soaps were very harsh on the skin and clothes due to the high base content. Even today, people with very sensitive skin must sometimes use a nonsoap-based product for bathing.

Some historical comments

Starting early in the 1200s, several strong [mineral acids](http://en.wikipedia.org/wiki/Mineral_acid) (the three most well-known: sulfuric, nitric and hydrochloric acid) were first isolated. Sulfuric acid was made by heating green vitriol [iron(II) sulfate] and condensing the vapor into water. Other vitriols gave the same product. Mixing a vitriol with nitre (potassium nitrate) and heating produced vapors which gave nitric acid. Adding sal ammoniac (ammonium chloride) to nitric acid gave *aqua regia,* so named for its ability to dissolve gold. Hydrochloric acid ("spirit(s) of salt" - a name still used in commerce/pharmacy as late as the early 1970s) also was known during the Middle Ages; certainly it was known to Paracelsus (early 1500s).

The word alkaline comes from the Arabic *al-qily*, which means "to roast in a pan" or "the calcinated ashes of plants." By leaching the ashes with water, it is possible to obtain a solution of sodium or potassium carbonate (to use the modern terms). This is then mixed with slaked lime (calcium hydroxide), resulting in a solution of NaOH or KOH. This technique was described in writing in the 900s, but may have existed for many years prior.

Source: <http://www.chemteam.info/AcidBase/Acid-Base-Properties.html>, with modifications

After you read the article, complete the following table:

|  |  |  |
| --- | --- | --- |
| Category | Acids | Bases |
| Effect on litmus |  |  |
| Effect on phenolphthalein |  |  |
| Taste |  |  |
| Electrolyte? Y/N |  |  |
| Reactions |  |  |

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SECTION: Introducing the pH Scale

Go to <http://www.compoundchem.com/2015/07/09/ph-scale/> and use this information to answer the following questions. Note: the colors in the infographic show the color changes for universal indicator at different pH values.

1. What pH range corresponds to basic (or alkaline) solutions?
2. List three everyday examples of basic substances
3. What pH range corresponds to acidic solutions?
4. List three everyday examples of acidic substances
5. Complete the following statements:

* For acidic solutions, [H+] is greater/less than/equal to [OH-]
* For basic solutions, [H+] is greater/less than/equal to [OH-]
* For neutral solutions, [H+] is greater/less than/equal to [OH-]
* As [H+] increases, the [OH-] \_\_\_\_\_\_\_\_

1. Can pH be greater than 14 or less than 0?
2. State the mathematical definition of pH
3. What pH is neutral for water? According to the article, what conditions are necessary for this to be an accurate statement?