Outcome 2
Topic 1 – Explaining the Properties of Acids and Bases

Table 1 Diagnostic Tests for Various Types of Solutions

Type of solute	Type of solution	Conductivity	Litmus	pH
most molecular compounds	neutral	no	no effect	7
most ionic compounds	neutral	yes	no effect	7
acids	acidic	yes	blue to red	<7
bases	basic	yes	red to blue	>7

<u>The theory of Acids and Bases as we know it now.</u>

- The theory that we currently use to explain acids and bases was developed in the late 1800's by Svante Arrhenius. He said that:

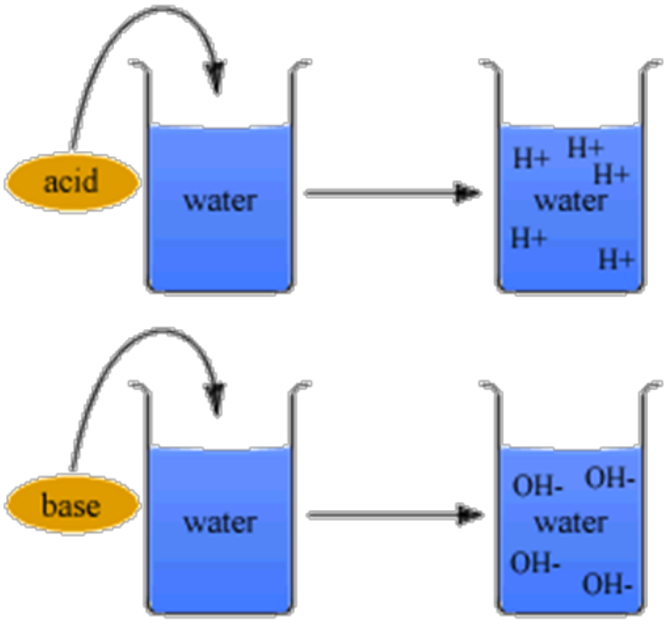
  - *Acids are substances that **ionize in aqueous solution to form hydrogen ions***

    $HCl_{(g)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$

  - *Bases are substances that **dissociate to form hydroxide ions in aqueous solution***

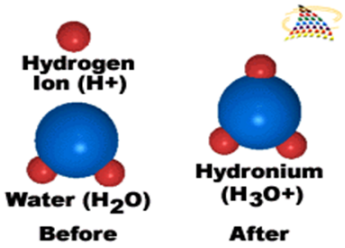
    $NaOH(s) \rightarrow Na^+_{(aq)} + OH_{-(aq)}$

- Although his theory has some drawbacks, as you will see later, it is still a widely used theory in many applications that require a simpler understanding of acids and bases



The Hydronium Ion

- Chemists thought that it was very unlikely that a hydrogen ion, which is a tiny proton with a very high charge-to-size ratio, could exist on its own in an aqueous solution.



- It is likely to bond strongly to polar water molecules.

$$H_2O_{(l)} + H^+_{(aq)} \rightarrow H_3O^+_{(aq)}$$

- The first empirical evidence for this bonding was provided in 1957 by Paul Giguère at the Université Laval, Quebec, with his discovery of the existence of hydrated protons.

- The simplest representation of a hydrated proton is $H_3O^+_{(aq)}$, commonly called the **hydronium ion**

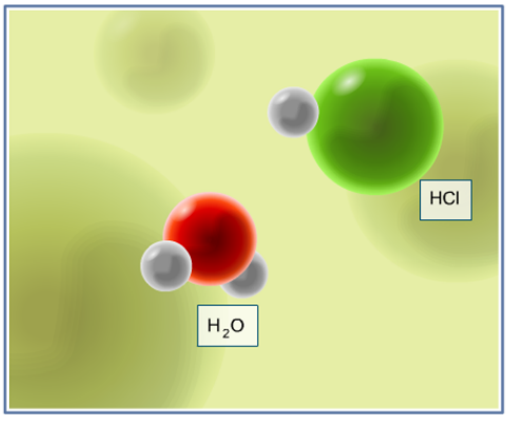
- **The current view of the nature of acidic and basic solutions is that hydronium ions are responsible for acidic properties and hydroxide ions are responsible for basic properties**

- The acidic or basic properties of a solution are most conveniently measured using paper test strips that have absorbed an indicator (such as litmus paper), but are most precisely measured using a pH meter

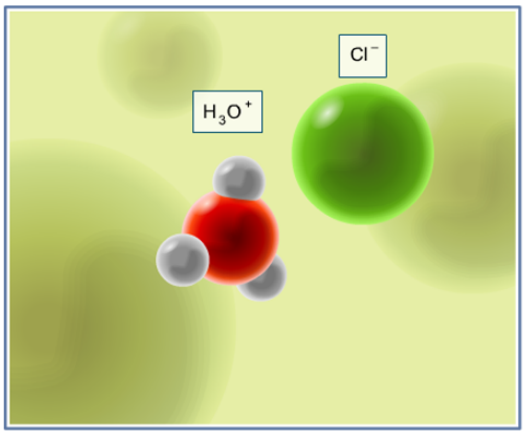
Animation showing hydronium ion formation

http://www.yteach.co.uk/page.php/resources/view_all?id=acid_base_salt_dissociation_neutralisation_solubility_electrolytic_t_page_6&from=search

Before



After



Pure water

- You might expect that a neutral solution of pure water does not contain any hydronium or hydroxide ions.

- Careful testing, however, yields evidence that neutral water (pH 7) always contains trace amounts of both hydronium and hydroxide ions, due to a very slight ionization

- In a sample of pure water, about two out of every billion molecular collisions are successful in forming hydronium and hydroxide ions

$$2\,H_2O(l) \xrightarrow{\text{very slight}} H_3O^+(aq) + OH^-(aq)$$

http://bio.winona.edu/berg/ANIMTNS/h30-an.gif

- This concentration is often negligible; for example, a conductivity test will show no conductivity for pure water unless the equipment is very sensitive

Practice Sheet 8

1. What is the most useful empirical property that can be used to distinguish acids, bases, and neutral compounds? Justify your answer.

2. Find and examine the label of one consumer product that contains an acid and one that contains a base. For each, identify any cautions noted for handling, storing, and disposing. Include the meaning(s) of any Household Hazardous Product symbols that indicate the primary hazard and the degree of hazard. Write the product name, the acid or base it contains and the symbol(s) it has on it.

3. What is the hydronium ion and how is it formed?