pH and Titration

Relation between pH and Hydrogen Ion Concentration

The pH scale is widely used to report the molar concentration of hydrogen ion, $H^+(aq)$, in aqueous solution. The pH of a solution is defined as

$$\text{pH} = -\log_{10}[\text{H}^+] \quad (1)$$

where $[H^+]$ = *the molar concentration of* $H^+(aq)$ in the solution. (In chemistry, square brackets around a chemical symbol mean *"the molar concentration of"* whatever they enclose.) Equation (1) above may be solved for $[H^+]$ to give

$$[\text{H}^+] = 10^{-\text{pH}} \quad (2)$$

(Here we use the well known rule that if $y = \log_{10} x$, then $x = 10^y$.) In practice, the pH scale is only used when $[H^+(aq)]$ is less than 1.0 M. See Chang, pp. 631-633, for further information.

Acidic, basic, and neutral solutions can be distinguished as shown below:

Type of Solution	pH	$[H^+]$	Color of litmus
Acidic	< 7.00	$> 1.0 \times 10^{-7}$	pink
Neutral	$= 7.00$	$= 1.0 \times 10^{-7}$	in between
Basic	> 7.00	$< 1.0 \times 10^{-7}$	blue

Titration

A titration is a procedure in which a solution of known concentration is used to determine the concentration of another solution with which it reacts. The reaction must be rapid and should go to completion. It may be an acid-base reaction, an oxidation-reduction reaction, or a precipitation reaction.

Typically a titration is conducted by filling a buret with one solution and transferring an exact amount of the second solution to an Erlenmeyer (conical) flask with a pipet. Indicator is added to the flask, and the first solution is added drop wise from the buret until the indicator changes color. The point of color change is called the *endpoint*, the *equivalence point*, or the *stoichiometric point* of the titration: all of these terms are synonymous. The indicator is chosen so the color change occurs when stoichiometric amounts of the reactants have been added to the flask.

The concentration of the unknown solution is calculated as illustrated in the exercise 3 below.

Exercises:

1. Use Eq (1) and the log_{10} button on your calculator to determine the pH of solutions with the specified hydrogen ion concentrations $[H^+]$:

	(a)	(b)	(c)	(d)	(e)	(f)
$[H^+]$	0.10 M	0.0010 M	10^{-7} M	5.0×10^{-10} M	6.0 M	1.0 M
pH						