Titration and Neutralization
Chemistry
Week 34

Name: _____

Date: _____

Acid-Base Titrations

An acid-base **titration** is a neutralization reaction that is performed in the lab in order to determine an unknown concentration (Molarity) of acid or base. As long as the concentration of one of the solutions is known, the concentration of the other reaction can be obtained through titration. In a titration reaction, the moles of acid equal the moles of base at the **equivalence point**. Once the equivalence point is reached the concentration of the unknown solution can be determined because:

$$M_aV_a = M_bV_b$$

Where
M_a = molarity of acid
V_a = molarity of base
M_b = molarity of base
V_b = volume of base

When you carry out a simple acid-base titration, an indicator is used to indicate when the acid and base have mixed in exactly the right proportion to neutralize each other. When the indicator changes color the **end point** of the titration has been reached. In an ideal world, the color change would happen when the two solutions are mixed in equal proportions. This is not always the case, but when it is, this point is known as the **equivalence point.** For strong acid/strong base reactions, the equivalence point occurs at pH =7.

If the pH of an acid is plotted against the amount of base added during a titration, the shape of the graph is called a **titration curve**. All acids titration curves follow the same basic shape. At the beginning, the solution has a low pH and climbs as the strong base is added. As the solution nears the point where all of the H^+ are neutralized, the pH rises sharply and then levels out again as the solution becomes more basic as more OH^- ions are added.

The titration curve in Figure 1 shows a strong acid being titrated by a strong base. There is the initial slow rise in pH until the reaction nears the point where just enough base is added to neutralize all the initial acid. This point is the **equivalence point**.

Use the graph and reading to answer the questions below on a separate sheet of paper.

1) Define the following terms: titration, equivalence point, end point, titration curve.

Figure 1

Titration: lab technique to determine unknown concentration.

Equivalence Point: equal proportion and pH 7

End point: ~~t~~ color change of solution

Titration Curve: graph of pH vs volume added, used to determine equivalence point.
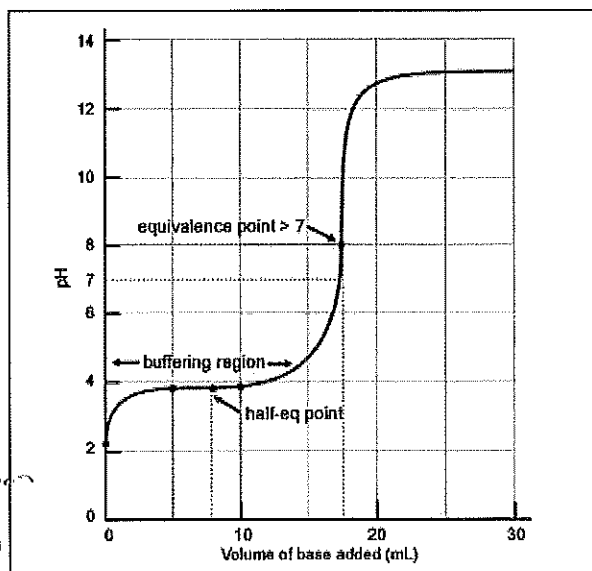
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2) Based on Figure 1, where does the pH begin and where does the pH end?

$start = 2.1$

$End = 13$

3) Based on figure one, what is the independent variable? What is the dependent variable?

Independent: volume added

Dependent: pH

Solve the neutralization problems below using the equation $M_aV_a = M_bV_b$. SHOW ALL WORK:

L.T. 10.2 and 10.3

4) If it takes 54 mL of 0.1 M NaOH to neutralize 125 mL of an HCl solution, what is the concentration of the HCl?

$.1(54) = M_2 \cdot 125$

$$M_2 = \frac{.1(54)}{125} = \boxed{0.0432 \ M \ HCl}$$

5) If it takes 25 mL of 0.05 M HCl to neutralize 345 mL of NaOH solution, what is the concentration of the NaOH solution?

$0.05(25) = M_b \cdot 345$

$M_a = 0.05$
$V_a = 25$
$M_b = ?$
$V_b = 345$

$$M_b = \frac{0.05(25)}{345} = \boxed{0.004 \ M \ NaOH}$$

6) If it takes 50 mL of 0.5 M $Ca(OH)_2$ solution to completely neutralize 125 mL of sulfuric acid solution (H_2SO_4), what is the concentration of the H_2SO_4 solution?

$M_a =$
$V_a = 125$
$M_b = 50$
$V_b = 0.5$

$M_a \cdot 125 = 50(.5)$

$$M_a = \frac{50(.5)}{125} = \boxed{0.2 \ M \ H_2SO_4}$$

7) How many milliliters of 0.360 M H_2SO_4 are required to neutralize 25.0 mL of 0.100 M $Ba(OH)_2$?

$M_a = 0.360$
$V_a = ?$
$M_b = 0.1$
$V_b = 25$

$0.360 \ V_a = 0.1(25)$

$$V_a = \frac{0.1(25)}{0.360} = \boxed{6.94 \ mL \ H_2SO_4}$$

8) What is the molarity of a 30.0mL hydrochloric acid solution (HCl) which is just neutralized by 48.0 mL of 0.100 M sodium hydroxide (NaOH)?

$M_a = ?$
$V_a = 30 \ mL$
$M_b = 0.100$
$V_b = 48 \ mL$

$M_a \cdot 30 = 0.100(48)$

$$M_a = \frac{0.100(48)}{30} = \boxed{0.16 \ M \ HCl}$$

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