Unit 5: Acids & Bases

Practice Set 3: 2-5, 3-1 to 3-2 Neutralization Reactions and Titration

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1. What is the approximate pH of a solution that is:

   a. yellow in methyl red, yellow in phenol red, and yellow in alizarin yellow? **6.0 – 6.6**

   b. yellow in methyl red, red in phenol red, and red in alizarin yellow? **12 or higher**

2. Write the general word equation for a neutralization reaction.

   Acid + Base → Salt + Water

3. Write **balanced** neutralization reactions for the following:

   a. the reaction between acetic acid, $HC_2H_3O_2$ and potassium hydroxide, KOH

   $HC_2H_3O_2 + KOH \rightarrow KC_2H_3O_2 + H_2O$

   b. the reaction between nitric acid, HNO_3 and calcium hydroxide, $Ca(OH)_2$

   $2\ HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2\ H_2O$

   c. the reaction between sulfuric acid, H_2SO_4, and sodium hydroxide, NaOH

   $H_2SO_4 + 2\ NaOH \rightarrow Na_2SO_4 + 2\ H_2O$

4. If 25.00 mL of a 0.100 M NaOH solution is required to neutralize 15.00 mL of a solution of HCl, what is the molarity of the acid?

Write the balanced equation: $\mathbf{HCl + NaOH \rightarrow NaCl + H_2O}$

The acid:base ratio is 1:1, therefore the formula used to calculate the unknown concentration is:

$$\mathbf{M_A V_A = M_B V_B}$$

Determine the values for the known variables:

M_A	M_A	M_B	0.100 M
V_A	15.00 mL	V_B	25.00 mL

Substitute values into the formula $M_A V_A = M_B V_B$ and solve for the unknown:

$$\mathbf{M_A V_A} = \mathbf{M_B V_B}$$
$$\mathbf{M_A\ (15.00)} = \mathbf{(0.100)(25.00)}$$
$$\mathbf{M_A\ (15.00)} = \mathbf{2.50}$$
$$\mathbf{M_A} = \frac{2.50}{15.00} = 0.167M$$

The concentration of the HCl solution is 0.167 M.

5. What is the concentration of a calcium hydroxide solution, $Ca(OH)_2$, if 30.00 mL of the base is completely neutralized by 10.0 mL of 0.0200 M HCl?

Write the balanced equation: $\mathbf{2\ HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2\ H_2O}$

The acid:base ratio is 2:1, therefore the formula used to calculate the unknown concentration is:

$$\mathbf{M_A V_A = 2\ M_B V_B}$$

Determine the values for the known variables:

M_A	0.0200 M	M_B	M_B
V_A	10.00 mL	V_B	30.00 mL

Substitute values into the formula $M_A V_A = M_B V_B$ and solve for the unknown:

$\mathbf{M_A V_A}$	=	$\mathbf{2\ M_B V_B}$
(0.0200) (10.00)	=	**2 (M_B)(30.00)**
0.200	=	**60.00 (M_B)**
$\frac{0.200}{60.00} = 0.00333M$	=	$\mathbf{M_B}$

The concentration of the $Ca(OH)_2$ solution is 3.33×10^{-3} M.