

# Module 11: Acid/Bases, Neutralization, and Redox Reactions

## Topic 4 Content: Solving a Titration Notes

### Introduction

The screenshot shows a digital interface with a black header bar containing the text "Solving a Titration". Below the header is a light purple bar with the word "Introduction". In the center, a white box contains the titration equation  $M_a \times V_a = M_b \times V_b$ . Below the equation, a paragraph of text explains that the equation can be rearranged to solve for unknown variables and that the user will learn how to solve a problem through three steps. At the bottom, there are three purple buttons labeled "Step #1 - Write a Balanced Equation", "Step #2 - List the Variables", and "Step #3 - Solve the Problem".

You can rearrange the titration equation to solve for any of the unknown variables in a titration. In this activity, click on each of the steps to learn how an example titration problem is solved.

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### Step #1 - Write a Balanced Equation

#### Solving a Titration

**Introduction**

**Step #1 - Write a Balanced Equation**

Imagine that 15.0 mL of a 0.125 mol/L solution of hydrochloric acid is titrated with a 12.5 mL solution of potassium hydroxide. What was the concentration of the hydroxide solution before the titration? To solve this problem, you will need to write out a balanced chemical equation. In order to do so, you must predict the products. The products in this reaction are potassium chloride and water.

Reactants		→	Products	
HCl	+ K <sup>+</sup> OH <sup>-</sup>		K <sup>+</sup> Cl <sup>-</sup>	+ H <sub>2</sub> O
Hydrochloric Acid	Potassium Hydroxide		Potassium Chloride	Water

**Step #2 - List the Variables**

**Step #3 - Solve the Problem**

Imagine that 15.0 mL of a 0.125 mol/L solution of hydrochloric acid is titrated with a 12.5 mL solution of potassium hydroxide. What was the concentration of the hydroxide solution before the titration? To solve this problem, you will need to write out a balanced chemical equation. In order to do so, you must predict the products. The products in this reaction are potassium chloride and water.

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### Step #2 - List the Variables

#### Solving a Titration

Introduction

Step #1 - Write a Balanced Equation

Step #2 - List the Variables

To find the concentration of the hydroxide solution before the titration, you will need to use the formula shown here. In this formula,  $M_a$  is equal to the molarity of the acid and  $V_a$  is equal to the volume of the acid.  $M_b$  represents the molarity of the base and  $V_b$  is equal to the volume of the base. Next, you will want to make a list of your known and unknown variables. Take a moment to view the known and unknown variables in the example titration.

$$M_a \times V_a = M_b \times V_b$$

Known:  
 $M_a = 0.125 \text{ mol/L}$   
 $V_a = (15.0 \text{ mL})$   
 $V_b = (12.5 \text{ mL})$

Unknown:  
 $M_b = ?$

Step #3 - Solve the Problem

To find the concentration of the hydroxide solution before the titration, you will need to use the formula shown here. In this formula,  $M_a$  is equal to the molarity of the acid and  $V_a$  is equal to the volume of the acid.  $M_b$  represents the molarity of the base and  $V_b$  is equal to the volume of the base. Next, you will want to make a list of your known and unknown variables. Take a moment to view the known and unknown variables in the example titration.

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#### Step #3 - Solve the Problem

**Solving a Titration**

Step #1 - write a balanced Equation

Step #2 - List the Variables

Step #3 - Solve the Problem

Known:  $M_a \times V_a = M_b \times V_b$   
 $M_a = 0.125 \text{ mol/L}$   
 $V_a = 15.0 \text{ mL}$   
 $V_b = 12.5 \text{ mL}$

Unknown:  $M_b = ?$

$$M_b = \frac{M_a \times V_a}{V_b}$$
$$M_b = \frac{0.125 \text{ mol/L} \times 15.0 \text{ mL}}{12.5 \text{ mL}} = 0.15 \text{ mol/L}$$

In order to solve the problem, you will need to rearrange the equation so that you are solving for the molarity of the base. Once you have rearranged the equation, substitute in the known values and solve the problem. The concentration of the hydroxide solution before the titration is found by multiplying 0.125 mol/L by 15.0 mL. Then, divide by 12.5 mL. The concentration of hydroxide solution prior to the titration is 0.15 mol/L.

In order to solve the problem, you will need to rearrange the equation so that you are solving for the molarity of the base. Once you have rearranged the equation, substitute in the known values and solve the problem. The concentration of the hydroxide solution before the titration is found by multiplying 0.125 mol/L by 15.0 mL. Then, divide by 12.5 mL. The concentration of hydroxide solution prior to the titration is 0.15 mol/L.