

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

## Topic 1 Application: pH Scale Scientific Investigation

Before you begin the scientific investigation below, make sure to download the *pH Scale Scientific Investigation Report*. As you complete this scientific investigation, fill in any needed information on the report template. If you need more information about each section of the report, please visit the Developmental Module.

### Introduction

The pH scale measures the acidity of a solution. The pH scale ranges from zero to fourteen. The pH scale number actually denotes the number of hydrogen (hydronium) ions or hydroxide ions. Solutions with a high concentration of hydronium ( $\text{H}_3\text{O}^+$ ) have a lower pH. Solutions with a higher concentration of hydroxide ( $\text{OH}^-$ ) have a higher pH. On the pH scale, any solution with a lower pH is considered to be an acid, while any solution with a high pH is considered to be basic.

### Objectives

In this scientific investigation, you will:

- observe how the concentrations of hydronium and hydroxide change by lowering or raising the pH of a solution.
- observe the pH, hydronium concentration, and hydroxide concentration in certain common solutions.

### Hypothesis

Using the **Procedure and Data Collection** section below, read through the procedural information for this scientific investigation. Based on your understanding of the procedure, develop your own hypotheses which describe the expected results. You should consider the following questions: How does the concentration of hydronium and hydroxide change with pH? How does the pH, concentration of hydronium, and concentration of hydroxide ions differ in common solutions? Record these hypotheses in the **Hypothesis** section of your *pH Scale Scientific Investigation Report*.

### Required Simulation

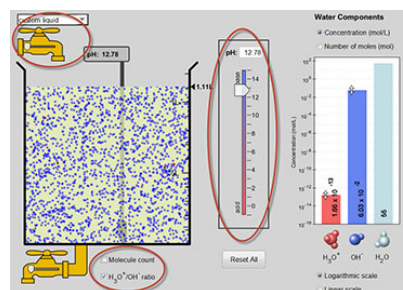
**pH Scale Simulation:** [http://phet.colorado.edu/sims/ph-scale/ph-scale\\_en.jnlp](http://phet.colorado.edu/sims/ph-scale/ph-scale_en.jnlp)

Provided by:  
PhET Interactive Simulations  
University of Colorado  
<http://phet.colorado.edu>

### Procedure and Data Collection

#### Simulation Set-Up

1. Open the pH Scale simulation.
2. Take a few moments to become familiar with the simulator. Adjust the pH scale bar, adjust the concentration of hydronium, adjust the concentration of hydroxide, and use the drop-down menu to view different solutions. View the image to the right to see



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

## Topic 1 Application: pH Scale Scientific Investigation

where each of these controls are located.

3. Once you are done experimenting with the simulation, click **Reset All** to reset the simulation.

### Procedure

1. Make sure that the check box labeled  $H_3O^+/OH^-$  ratio is checked. In the solution, the red dots represent hydronium ions and blue dots represent hydroxide ions.
2. Adjust the pH slider up and down; observe how moving the slider changes the number of each type of ion. On your *pH Scale Scientific Investigation Report*, make some general observations about what happens when you raise the pH slider up. On your *pH Scale Scientific Investigation Report*, make some general observations about what happens when you lower the pH slider down.
3. Click **Reset All** to reset the simulation. Make sure that the check box labeled  $H_3O^+/OH^-$  ratio is checked.
4. Using the drop-down menu in the top left corner, record the pH,  $H_3O^+$  content, and the  $OH^-$  content for each of the substances listed below. Place these measurements in the data table provided on your *pH Scale Scientific Investigation Report*:
  - Drain Cleaner
  - Hand Soap
  - Blood
  - Spit
  - Water
  - Milk
  - Coffee
  - Beer
  - Soda
  - Vomit
  - Battery Acid

### Data

Use the data table provided on your *pH Scale Scientific Investigation Report* to record your data from this scientific investigation. The data table is also shown below.

Solution	pH	$H_3O^+$ Content	$OH^-$ Content
Drain Cleaner			
Hand Soap			
Blood			
Spit			
Water			
Milk			
Coffee			
Beer			
Soda			

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

## Topic 1 Application: pH Scale Scientific Investigation

Vomit			
Battery Acid			

### Data Analysis

In the **Data Analysis** section of your *pH Scale Scientific Investigation Report*, provide the responses to the following questions:

1. When pH was raised, what type of ion concentration increased?
2. When pH was lowered, what type of ion concentration increased?
3. Explain the difference between a low pH and a high pH.
4. Which of the substances tested in this investigation was the most basic? Which was the most acidic?

### Conclusion

Using the *pH Scale Scientific Investigation Report*, compose three to four sentences describing an overall conclusion about the relationship between pH and concentration of hydronium and hydroxide. Base your conclusions on your data. Were your hypotheses true or false, and how do you know? Use the data and notes that you collected from your simulation experience to form your conclusion. Make sure that you include information that you gained from data analysis to support your conclusion.

### Experimental Sources of Error

On your *pH Scale Scientific Investigation Report*, provide responses to the following questions: Are there any sources of error? If so, what are they, and what could be done to minimize error?



Once you have completed the *pH Scientific Investigation Report*, please submit your work to the dropbox.