pH Lab Worksheet

Acids, bases, indicators, and titration · Logical Home Schooling

Name: _____ **Date:** _____ **Period:** _____

In this lab you will use pH Lab to test household substances, compare acid-base indicators, explore the math behind the pH scale, and run titrations to find the concentration of an acid.

Link: www.logicalhomeschooling.com/ph-lab.html

Objectives

By the end of this lab you will be able to:

- Measure pH and classify substances as acidic, neutral, or basic.
- Compare indicators and use them to identify unknown solutions.
- Explain why each pH unit is a tenfold change, and calculate pH, pOH, $[H^+]$, and $[OH^-]$.
- Use a titration to find the concentration of an acid, and compare strong and weak acids.

Materials: a computer or tablet with pH Lab open, a calculator, a pencil, this worksheet. Time: about 60 minutes.

Key equations. $pH = -\log[H^+]$ · $[H^+] = 10^{-pH}$ · $pH + pOH = 14$ · $[OH^-] = 10^{-pOH}$ · $M_aV_a = M_bV_b$

Below 7 is acidic, 7 is neutral, above 7 is basic. Each pH unit is a 10× change in $[H^+]$.

Part 1: Pre-lab

1. List two acids and two bases you might find at home.

   _____

2. What do you think "neutralize" means when an acid and a base are mixed?

   _____

Part 2: Stage 1, The pH scale

Test each substance. Record the paper color, your estimate from the chart, the pH meter reading, and the type.

Substance	Paper color	Your estimate	pH meter	Acid, neutral, or base?
Lemon juice				
Vinegar				
Orange juice				
Black coffee				
Milk				
Pure water				
Baking soda solution				
Milk of magnesia				
Household ammonia				
Drain cleaner				

Write each substance's name above its place on the scale:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

1. Which substance is the strongest acid? The strongest base?

2. What do most of the foods and drinks have in common? What about the cleaning products?

Part 3: Stage 2, Indicators

Record the color each indicator turns in each solution.

Solution	pH	Red cabbage juice	Litmus	Phenolphthalein
Vinegar	2.8			
Pure water	7.0			
Milk of magnesia	10.5			
Drain cleaner	13.5			

1. Which indicator is the most useful for estimating pH? Why?

2. Phenolphthalein stayed colorless in vinegar and in water. Why can't it tell you which one is acidic?

Mystery solutions. Record the colors you saw and your conclusion.

Unknown	Red cabbage	Litmus	Phenolphthalein	Classification
A				
B				
C				
D				

Part 4: Stage 3, pH math

pH	$[H^+]$ (M)	pOH	$[OH^-]$ (M)
3.0			
5.0			
7.0			

1. How many times more H^+ is in a solution at pH 3 than at pH 5? Explain.

Dilution. Record the pH of each beaker.

Beaker	Stock	1	2	3	4	5	6
pH							

2. Why does the pH stop going up by exactly 1 after the fifth dilution? Can water make an acid basic?

Calculations. Show your work.

Problem	Work	Answer
$[H^+] = 1.0 \times 10^{-4}$ M. pH = ?		
$[H^+] = 3.2 \times 10^{-3}$ M. pH = ?		
pH 9.0. pOH = ? and $[OH^-]$ = ?		
pH 3.7. $[H^+]$ = ?		

Part 5: Stage 4, Titration

Record your data for each titration.

Titration	Acid volume (mL)	NaOH concentration (M)	Endpoint volume (mL)	Moles of NaOH	Acid concentration (M)
1: HCl, 0.100 M	25.0	0.100			0.100 (given)
2: Unknown HCl	20.0	0.150			
3: Vinegar (acetic acid)	25.0	0.100			

Sketch the HCl curve: pH vs. NaOH added

Sketch the vinegar curve: pH vs. NaOH added

1. Write the balanced equation for the reaction of HCl with NaOH. What is in the flask at the endpoint?

2. Why is it important to add NaOH one drop at a time near the endpoint?

3. Compare the two curves. Give two differences between the strong acid (HCl) and the weak acid (vinegar).

4. Why was the pH at the vinegar equivalence point above 7?

Part 6: Practice problems

Answer these **without** pH Lab. Show your work.

1. Which is more acidic, a solution at pH 4 or one at pH 6? How many times more H^+ does it have?

2. A solution has $[H^+] = 1.0 \times 10^{-9}$ M. What is its pH? Is it acidic or basic?

3. A cleaner has pH 11. What are its pOH and $[OH^-]$?

4. It takes 15.0 mL of 0.200 M NaOH to neutralize 30.0 mL of HCl. What is the concentration of the HCl?

5. Phenolphthalein turns pink at about pH 8.2, not 7. Why is it still a good indicator for titrating HCl with NaOH? (Hint: look at your HCl curve.)

6. Milk of magnesia is used to treat heartburn, which is caused by stomach acid. Explain how it works.

Conclusion

Write 3 to 5 sentences explaining what pH measures and how a titration uses neutralization to find an unknown concentration. Use the words **acid**, **base**, **indicator**, **neutralization**, and **endpoint**.