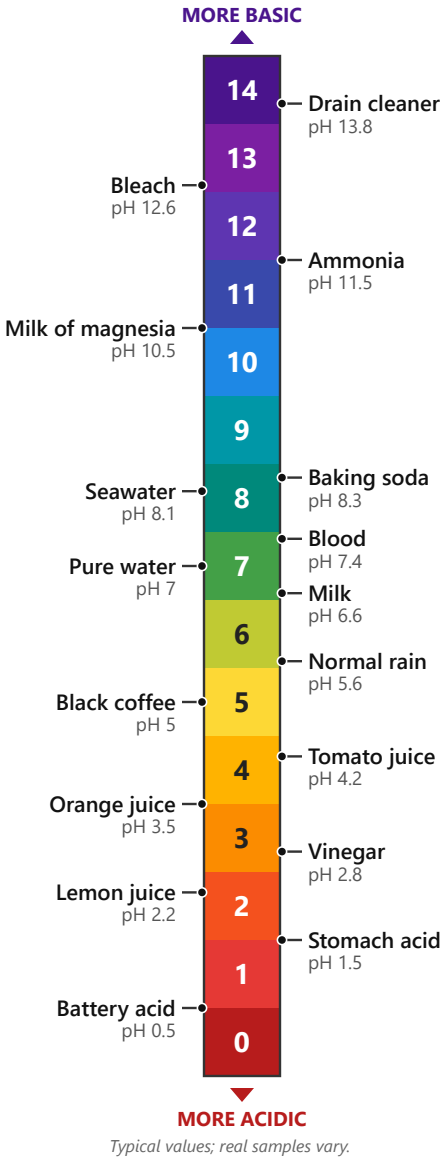
Name _____ Date _____ Period _____

The pH Scale

Exploring acids, bases, and the power of ten



Typical values; real samples vary.

Explore

Almost every liquid around you — lemon juice, saliva, pool water, even drain cleaner — contains **hydrogen ions**, written H^+. The **pH scale** describes how concentrated those ions are. It usually runs from **0 to 14**.

Acidic pH below 7	More H^+ than pure water. Acids taste sour (never taste-test in a lab!), turn blue litmus paper red, and react with many metals.
Neutral pH = 7	Pure water at 25 °C. H^+ and hydroxide ions (OH^-) are balanced.
Basic pH above 7	More OH^- than H^+. Bases (also called *alkaline*) taste bitter, feel slippery, and turn red litmus paper blue.

Key idea: the scale counts by tens. Each step of 1 pH unit is a **10×** change in H^+. pH 4 has 10 times more H^+ than pH 5, and 100 times more than pH 6. **Lower pH → more H^+ → more acidic.**

Part A · Read the Scale

Use the scale at left.

1. Label each substance **A** (acidic), **N** (neutral), or **B** (basic).

Black coffee _____ Ammonia _____ Pure water _____

Seawater _____ Tomato juice _____ Bleach _____

2. Which is more acidic, orange juice or milk? Use their pH values to explain.

3. Healthy blood stays between pH 7.35 and 7.45. Is blood slightly acidic or slightly basic? How do you know?

4. A student says, "Bleach has a high pH, so it's safe. Only acids are dangerous." Do you agree? Explain.

Part B · The Power of Ten

5. Complete the table. Count the steps between the two pH values; each step multiplies H^+ by 10.

More acidic	Less acidic	Steps apart	Times more H^+
pH 5	*pH 6*	*1*	*10 (example)*
pH 3	pH 6		
pH 2 (lemon juice)	pH 7 (pure water)		
pH 4	pH 8		

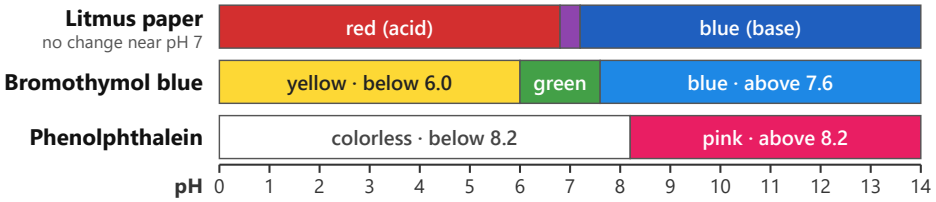
6. Normal rain has a pH of about 5.6 because it dissolves carbon dioxide from the air. Rain with a pH of 4.6 is called *acid rain*. How many times more acidic is it than normal rain?

7. Maya says pH 2 is "only a little more acidic" than pH 4 because 2 and 4 are close numbers. Explain her mistake.

Turn over →

Part C · Indicators: Seeing pH with Color

An **indicator** is a dye that changes color when the pH changes. Each indicator changes at its *own* pH, so testing a sample with two or three indicators narrows down its pH.



8. Use the chart to complete the table for four unknown solutions. In the last column, name a substance from the front that fits.

Solution	Litmus	Bromothymol blue	Phenolphthalein	Acidic, basic, or neutral?	pH is between…	Could be…
A	*red*	*yellow*	*colorless*			
B	*blue*	*blue*	*pink*			
C	*no change*	*green*	*colorless*			
D	*blue*	*blue*	*colorless*			

9. What do the other two indicators tell you about Solution D that litmus can't? Why use more than one indicator?

Part D · pH in the Real World

Heartburn & antacids

Stomach acid (about pH 1.5) helps digest food. Heartburn happens when some splashes up into the esophagus. Antacids contain a base, such as calcium carbonate. Acids and bases cancel out in a **neutralization** reaction:

acid + base → salt + water

10. Explain how an antacid eases heartburn. Use the word *neutralize*.

Ocean acidification

The ocean absorbs carbon dioxide (CO_2) from the air, forming carbonic acid. Since the 1700s, the average pH of the ocean's surface has dropped from about 8.2 to about 8.1.

11. (a) Is the ocean still basic? (b) Why is this called "acidification"? (c) Calcium carbonate shells dissolve more easily as pH drops. Predict one effect on sea life.

Garden chemistry

Some hydrangea bushes change flower color with soil pH: **blue** flowers in acidic soil, and **pink** flowers in neutral or basic soil.

12. A gardener has pink hydrangeas but wants blue ones. Should the soil become more acidic or more basic? Will its pH number go up or down?

Part E · Challenge: The Numbers Behind the Scale

Chemists measure H^+ in moles per liter, written $[H^+]$. The pH is the exponent: $\mathbf{[H^+] = 10^{-pH}}$. So pH 3 means $[H^+] = 10^{-3} = 0.001$ mol/L.

13. Complete the table.

pH	$[H^+]$ as a power of 10	$[H^+]$ as a decimal (mol/L)
1		
3	*10^{-3}*	*0.001 (example)*
	10^{-5}	
7		

14. You keep adding water to a glass of lemon juice. What happens to its pH? Can it ever rise above 7? Explain.

15. In one or two sentences, explain to a younger student what the pH of a liquid tells you.