Name: ______________________

**Understanding pH**

**Pre-Quiz**
Your teacher will reveal a set of numbers on the board. Your goal is to write the numbers down *in numerical order* (smallest to largest) as fast as you can. Raise your hand when finished.

Write the 8 numbers in order below.

Time it took to put them in order: ______

**Background**
The goal of this activity is to introduce the base 10 logarithmic scale, show that it is a more efficient method of expressing very small or large numbers, and to practice calculating pH values. pH values are used to show how acidic or basic a substance is.

Necessary equation: Recall the autoionization constant for water, $1.0 \times 10^{-14}$, and the corresponding equation, $K_w = [H^+][OH^-]$.

**Activity**

**What is a log?**

$2^x = 8$  Find $x$

For more complicated problems, we can use logarithms. We need only use the base 10 logarithm—the power to which 10 must be taken to yield that number.

$10^x = 1000$  where $x = 3$  can also be expressed as $\log 1000 = 3$

Try the following: (If you get stuck, ask yourself “to what power must 10 be raised to equal the bolded number?”)

Log 10 =
Log 1 =
Log 100,000,000 =
Log 0.001 =
Log 1.0 x $10^{-8}$ =

Note how easy the above problems are when put into scientific notation. Explain why the following problem is more complicated than the previous ones.

Log 650 =

The number 650 is between 100 and 1000, so the answer must be between ____ and ____.
**Using your Calculator**

Log 650 =

Directions on how to enter this into my calculator:

**Calculating pH**

\[
\text{pH} = -\log [\text{H}^+], \text{ where brackets mean concentration in M}
\]

Find pH when \([\text{H}^+] = 2.6 \times 10^{-6} \text{ M}\)

Find pH when \([\text{H}^+] = 1.8 \times 10^{-6} \text{ M}\)

Find pH when \([\text{H}^+] = 3.9 \times 10^{-4} \text{ M}\)

Notice that it is easier to compare pH values since concentration values are so small.

The ________ the \([\text{H}^+]\), the ________ the pH.

Note that pH values do not have units.

**Acidic or Basic?**

When \([\text{H}^+] > [\text{OH}^-]\), the solution is acidic

When \([\text{H}^+] < [\text{OH}^-]\), the solution is basic

When \([\text{H}^+] = [\text{OH}^-]\), the solution is neutral

Find \([\text{H}^+]\) in a neutral solution using the equation for \(K_w\):

What is the pH of this neutral solution?

Therefore, when pH < ______, the solution is __________

When pH > ____________, the solution is ____________

When pH = __________, the solution is ____________

**A note on Sig Figs**

For pH: Since the number to the left of the decimal point is simply an exponent, it does not count as a significant figure. Therefore, only numbers to the right of the decimal point count.

For \([\text{H}^+]\): Regular significant figure rules apply because it is a measured value.
6.8  \rightarrow  \text{____ sf}
12.672  \rightarrow  \text{_____ sf}

[H^+] = 1.00 \times 10^{-2}, \text{ find pH _______} \rightarrow \text{ pH has _____ sf, even though there are ___ digits}

**Antilog**

\[10^{\text{pH}} = [H^+]\text{ which is the inverse of log}\]

Use antilog when you have the pH and are trying to find [H^+].

If you ever get confused, remember that log 1 = 0, so antilog of 0 is 1, or \(10^0 = 1\)

Find [H^+] of a solution if pH = 4.97.

Directions on how to enter this into my calculator:

**Post-Quiz**

Your teacher will reveal a set of numbers on the board. Your goal is to write the numbers down *in numerical order* (smallest to largest) as fast as you can. Raise your hand when finished.

Write the numbers in order below.

Time it took to put them in order:  _______

Compare your time for the pre-quiz with that of the post-quiz. If they differed, why do you think that was the case?

Propose a reason for the negative sign in the calculation of pH.
Practice Problems

Use the following relationships to solve the problems below.

\[
K_w = [H_3O^+] [OH^-] = 1.0 \times 10^{-14} @ 25^\circ C
\]

\[
pH = - \log [H^+] \text{ (or, solving for } [H^+] = 10^{-pH})
\]

\[
pOH = - \log [OH^-] \text{ (or, solving for } [OH^-] = 10^{-pOH})
\]

\[
pH + pOH = 14
\]

1. pH = 1.34, find pOH

2. \([H_3O^+] = 8.20 \times 10^{-9} \text{ M}, \text{ find } [OH^-]\)

3. \([H_3O^+] = 8.20 \times 10^{-9} \text{ M}, \text{ find } \text{pH}\)

4. \([OH^-] = 6.4 \times 10^{-12} \text{ M}, \text{ find } \text{pOH}\)

5. \([H_3O^+] = 3.65 \times 10^{-2} \text{ M}, \text{ find } \text{pOH}\)

6. The pH of black coffee is 5.66, find \([H_3O^+]\)

7. Some battery acid has pOH = 13.06, find \([H_3O^+]\)

8. Circle the acidic solutions in the above problems.

9. Coca-Cola has a pH value of 2.53, while Barq's Root Beer has a pH of 4.61.
   a. Find \([H_3O^+]\) of each soft drink.
   b. Which drink is more acidic?
   c. How many times more acidic is the drink you chose in Part b?

10. Briefly research the Richter scale, used to describe the magnitude of earthquakes. Explain its significance to today's topic.