The pH Scale

6.5 - pH and pOH Scale

pages 608-614 in Matter and Change

He's a 10?

Maybe on the pH scale, because he's basic
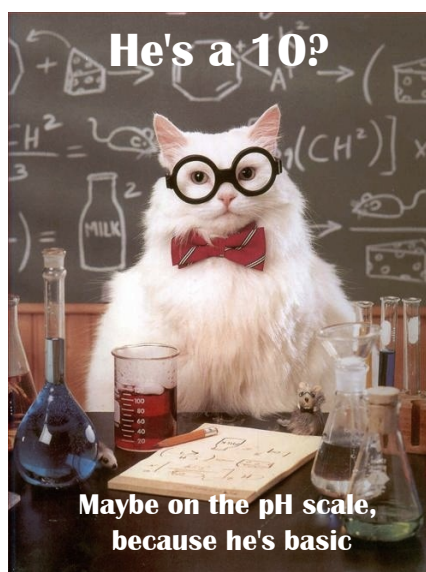
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When we refer to the pH scale, we are actually just referring to $[H^+]$ ions in an acidic or basic solution (by comparing this concentration to neutral water).

- These concentrations are often very small (i.e. 1.3×10^{-3}) and cumbersome to work with.

We use the pH scale because these concentrations are converted to easier numbers to work with.
- pH is defined as the negative log of the concentration of hydrogen ions in a solution. Therefore, **pH scale is a logarithmic scale.**

$$\boxed{pH = -\log [H^+]}$$

Ex) Find the pH of the $[H^+]$ values given below:
   a) 1×10^{-3}

   c) 4.7×10^{-9}

   d) 1.0×10^{-7}

Solutions with $[H^+] > 1.0 \times 10^{-7}$ are acids.
Solutions with $[H^+] < 1.0 \times 10^{-7}$ are bases.

Acids	Bases	Neutral
pH < 7	pH > 7	pH = 7
lower number = stronger	higher number = stronger	

Note: Each jump on the pH scale is an increase in strength of 10. For example, an acid at pH 3 is ten times stronger than an acid at pH 4. Likewise, an acid at pH 3 is 100 times as strong as a pH 5. Same thing with bases. A base at pH 11 is ten times weaker than a base at 12.

Sometimes you have to calculate the $[H^+]$ before you can determine pH.

Ex) Calculate the pH of 0.0100 M HNO_3 solution. Is this solution acidic or basic?

pOH

If we have a scale based on [H $^+$] then there should also be a scale based on [OH$^-$]. This is referred to as pOH.

$$pOH = - \log [OH^-]$$

$$pH + pOH = 14$$

Ex) Calculate the pH of a solution made by mixing 0.20 g of NaOH with water to make a .500 L solution.

NOTE: If we are given the pH or pOH of a solution, we can use it to calculate the [H$^+$] or [OH$^-$].

$$[H^+] = \text{antilog } (-pH)$$

$$[OH^-] = \text{antilog } (-pOH)$$

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Ex) What is the $[H^+]$ for a solution with pH of 8.3?

Ex) Find the hydronium ion concentration in a solution with a pH of 12.6.

Ex) What are the $[H^+]$ and $[OH^-]$ in a healthy person's blood that has a pH of 7.40? Assume that the temperature is 298K.

K_a and pH

What pH results when 0.25 mol of acetic acid, CH_3COOH is dissolved in enough water to make 1 L of solution?

To find pH we need to determine $[H^+]$...
1. Write down the dissociation equation
2. Determine the K_a
3. Determine $[CH_3COOH]$
4. Write down equilibrium expression (K_a)
5. Find pH using $pH = -\log[H^+]$

Ex) A 0.24M solution of the weak acid, H_2CO_3, has a pH of 3.49. Determine the K_a for H_2CO_3.

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6.5 – pH and pOH Scale Assignment

1. Calculate the pH of a solution of nitric acid that:

   a. has a concentrations of 1.0×10^{-4} M

   b. consists of 6.3 g of solute dissolved in 1.00 L of solution?

2. Calculate the pH of a solution that consists of 5.0 g of HCl in 250 mL of solution.

3. What is the [H$^+$] of a solution with a pH of 10.0 at 25°C? What is the pOH?

4. What is the pH of an aqueous solution containing 0.00200 M barium hydroxide, Ba(OH)$_2$, a strong base?

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5. Challenge: Determine the K_b for the benzoate ion, $C_6H_5COO^-$.

6. Calculate the pOH of a 0.100 M solution of acetic acid.

7. A 2.67 g sample of hydrogen fluoride gas (HF) is dissolved in sufficient water to make 1.05 L of solution at 25°C to form an acidic solution. Hydrogen fluoride is a weak acid with $K_a = 6.6 \times 10^{-4}$.

    Calculate the pOH of this solution.

8. Challenge: A 0.20 M solution of a weak acid has a pH of 1.67. Calculate the K_a of this acid. Assume a 1:1 ratio in the ionization equation.