**Acid and Base pH PhET** 

In this simulation, you will observe ions and changes in hydronium (H3O+) and hydroxide (OH-) concentrations in several common substances. The autoionization constant of water (at 25ºC) Kw is 1 X 10-14 and is equal to the product of [H3O+] and [OH-]. When the “**p**” or negative logarithm is applied to each term, the relationship exists that **pH + pOH = 14**.

We can calculate a solution’s pH using a logarithm, which determines a number’s base-ten exponent. The “p” in pH is a negative logarithm (-log). We will investigate this in part II of the sim.

In part III, we will determine the number of moles of hydronium present in solution, when concentration and volume is known. These are powerful tools that allow us to measure and determine analytically a solution’s acidic or basic properties.

**Procedure:** *PhET Simulations 🡪 Play With Sims 🡪 Chemistry🡪 pH Scale 🡪*  

[(click to go directly to site)](http://phet.colorado.edu/en/simulation/ph-scale)

* Click on ***H3O+/OH- ratio*** box to view the hydronium and hydroxide molecules as model dots in solution.
* Spend a few minutes to become familiar with the simulation and its controls.
* Observe the pH of some common liquids.

**Part I: Changes in Hydronium H3O+ and Hydroxide OH- Concentrations**

* Make sure you are viewing concentrations in mol/L.

* Move the pH slider to create custom liquids with varying pH. Observe how increasing the pH on the slider affects the pH and concentrations of hydronium [H3O+] and hydroxide [OH-].

**Part I Analysis**

As pH increases, the concentration of hydronium [H3O+] \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

As pH increases, the concentration of hydroxide [OH-] \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

For any substance, when I multiply [H3O+] by [OH-] I always get \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

How does adding more or less of a liquid change the [H3O+]?

 **Part II: pH – [H3O+] Calculations**

* Choose several of the sample liquids and observe their H3O+ concentrations
* Find the “pH” of a few sample liquids by taking the negative logarithm of the liquid’s H3O+ concentration
* Complete the table below

**Sample Liquid Used [H3O+] Concentration [M] pH (-log [H3O+] )**

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

Do your calculations for pH match the pH identified in the simulation? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

How does the pH change as [H3O+] increases? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part III: Volume and Molarity**

* Use  and  to increase or decrease the volume of your liquids.
* You can toggle between concentration and number of moles with the button shown.
* Observe the effect of changing volumes on the number of moles of H3O+ and OH-.
* Choose several of the sample liquids and observe their H3O+ concentrations
* Find the number of moles of a few sample liquids by multiplying [H3O+] by volume
* Complete the table below. Do the calculation for moles and check your work in the simulation by selecting “Number of moles (mol)”

**Sample Liquid Used [H3O+] Concentration [M] Volume Used ( L ) Number Moles (mol)**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Part III Analysis**

The **unit** that is the product of concentration (mol/L) and volume (L) is \_\_\_\_\_\_\_\_\_\_\_\_\_.

Do your calculations for moles match the moles in the simulation? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Concentration and volume are equal only when volume is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Conclusion*:* Where calculations are made…show work. Use separate paper if needed.**

1. Of 1.0 x 10-6 and 1.0 x 10-4, the larger number is 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. The logarithm of 100 (aka 102) is 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
3. The logarithm of .001 (aka 10-3) is 3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. The logarithm of 2.5 x 10-3 is 4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
5. The solution to 1 x 10-14 / 3.6 x 10-8 is 5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

***Part I***

1. Acids have \_\_\_\_\_\_\_\_\_\_\_\_\_ pH while bases have \_\_\_\_\_\_\_\_\_\_\_\_\_\_ pH.
2. pH is a logarithmic scale. This means that for a change of pH 3 to pH 2, the hydronium ion concentration [H3O+] changes by 7. \_\_\_\_\_\_\_\_\_\_\_\_\_.
3. Acids have a [H3O+] that is *greater than / less than* (circle) 8. \_\_\_\_\_\_\_\_\_\_\_*M*.
4. Bases have a [H3O+] that is *greater than / less than* (circle) 9. \_\_\_\_\_\_\_\_\_\_\_*M*.
5. The product of [OH-] and [H3O+] for any solution is always 10.\_\_\_\_\_\_\_\_\_\_\_*M*.
6. In neutral water both [H3O+] and [OH-] equal 11. \_\_\_\_\_\_\_\_\_\_*M*.
7. When [H3O+] = 2.3 x 10-4, the [OH-] must equal 12. \_\_\_\_\_\_\_\_\_\_*M*.
8. When [OH-] = 4.5 x10-9, the [H3O+] must equal 13. \_\_\_\_\_\_\_\_\_\_*M*.

***Part II***

1. Soda pop has a pH of 2.5. What is it’s [H3O+] concentration? 14. \_\_\_\_\_\_\_\_\_*M*.
2. What is soda’s [OH-]? 15. \_\_\_\_\_\_\_\_\_*M*.
3. An unknown solution is found to have a [H3O+] of 3.8 x 10-5. What is its pH?

***Adapted from Chris Bires’*** [C:\Done at School - To Move Home\Acid Base pH PhET Lab.docx](http://phet.colorado.edu/files/activities/3284/C%3A_Done%20at%20School%20-%20To%20Move%20Home_Acid%20Base%20pH%20PhET%20Lab.docx)

***Part III***

1. How many moles of hydronium are present in 0.85 L of a 5.25 x 10-5 M solution?
2. How much (volume) of .15 M NaOH would be required to have .60 moles of OH?
3. If 250 mL of an unknown acid was found to contain 0.45 moles of H+ ions, what concentration was the unknown acid?
4. What volume of coffee (pH = 5.0) would be required to have .25 moles of H3O+ ions? (hint: two steps)