Intro Screen

In this screen, students explore the properties of acids and bases using particulate level diagrams, graphs and tools such as a pH meter, pH paper, and a conductivity tester.

MEASURE the pH of the solution

COMPARE balanced equation for acids and bases

$HA + H_2O \longrightarrow A^- + H_3O^+$

CHOOSE solution to investigate

DISPLAY molecules or a graph to identify solution components

USE pH meter, pH paper or conductivity meter to measure solution properties

My Solution Screen

Students create solutions to explore the differences between strong versus weak and concentrated versus dilute acidic or basic solutions.

MEASURE solution conductivity

$B + H_2O \rightleftharpoons BH^+ + OH^-$

CREATE an acidic or basic solution

VARY the initial concentration of the solution

CHANGE the relative strength of the acid or base

Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a `?` to the sim URL, and separating each query parameter with a '`&`'. The general URL pattern is:

`…html?queryParameter1&queryParameter2&queryParameter3`

For example, in Acid-Base Solutions, if you want to display the solvent molecules in the beaker (`showSolvent=true`) and only use the 1st screen (`screens=1`) use:

https://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_all.html?showSolvent=true&screens=1

To run this in Spanish (`locale=es`), the URL would become:

https://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_all.html?locale=es&showSolvent=true&screens=1

⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	Example Links
⚙ `showSolvent` - when `true`, displays the solvent molecules in the Particles view of the beaker. Default is `false`.	`showSolvent=true`

`screens` - specifies which screens are included in the sim and their order. Each screen should be separated by a comma. For more information, visit the Help Center.	`screens=1`
	
	`screens=2,1`

`initialScreen` - opens the sim directly to the specified screen, bypassing the home screen.	`initialScreen=1` `initialScreen=2`
⚙ `locale` - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on the simulation page on the Translations tab. Note: this only works if the simulation URL ends in "_all.html".	`locale=es` (Spanish) `locale=fr` (French)
`audio` - if muted, audio is muted by default. If disabled, all audio is permanently turned off.	`audio=muted` `audio=disabled`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`
`supportsPanAndZoom` - when `false`, disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is `true`.	`supportsPanAndZoom=false`

Insights into Student Use

- Students often confuse acid/base strength and concentration. For example, students often think that a stronger acid means the acid is more concentrated.
- In a classroom study, we found that students tend to think that pH measures the strength of an acid or base.

- Interviews revealed that students who had not received instruction on acids and bases found the generic representations of acids (HA) and bases (B) confusing at first. You may wish to introduce the idea of generic representations by first giving examples of real compounds (e.g.. HCl and HF) and then introducing the generic representation before students interact with the simulation.
- Many students are not aware that the initial concentration of an acid or base can be different than the equilibrium concentration. The graph is labeled to show it measures the concentrations of all species at equilibrium.

Model Simplifications

- The number of particles in the magnifying glass is related to the equilibrium concentration. We chose to ignore the auto-ionization of water for acid and base solutions.
- Because the actual values are hidden in the Introduction screen, students can use the equilibrium concentrations to calculate the initial concentration of acid/base and K_a/K_b. The initial concentration is 0.01 M for all solutions and the equilibrium constant is 1×10^{-7} for the weak acid/base.
- We chose to hide the K values in the My Solution screen, enabling students to focus on the concept of strength. The K values for the weak/strong slider range in value from 1×10^{-10} to 1×10^2 on a log scale.
- The pH meter and pH paper must be dipped into the solution to measure pH. Students can use this feature to predict the pH for different solutions.
- The pH paper colors are based on commercially available test strips and adjusted for colorblind accessibility. The colors used int he simulation may differ from the test strips used in your classroom.
- When using the conductivity probe, the brightness of the bulb scales linearly with pH. Note that the conductivity of distilled water is not measurable with equipment typically available to students, so it will not light up in the simulation.

Suggestions for Use

Sample Challenge Prompts
- List the properties of acidic and basic solutions using what you have observed in the simulation.
- What ions are present in an acidic solution? What ions are present in a basic solution?
- Describe the difference between a strong and weak acid or base.
- Describe the difference between acid strength (strong versus weak) and acid concentration (concentrated versus dilute).
- A student claims, "Strong acids always have a lower pH than weak acids." Do you agree or disagree with this claim? Use evidence from the simulation to support your reasoning.
- What happens to the pH of an acidic solution as the initial concentration is increased? Why do you think this happens?

See all published activities for Acid-Base Solutions here.
For more tips on using PhET sims with your students, see Tips for Using PhET.